HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Joint Session on Going To and Beyond the Earth-Moon System: Human Missions to Mars, Libration Points and NEO's (4-D2.8)

Author: Mr. Mattia Giovannini
Politecnico di Torino, Italy

Mr. Paolo Maggiore
Politecnico di Torino, Italy
Mr. Andrea Messidoro
Politecnico di Torino, Italy
Mr. Emanuele Tracino
Thales Alenia Space Italia, Italy
Prof. Laura Montanaro
Politecnico di Torino, Italy

RADIATION PROTECTION DESIGN OF A MANNED INFRASTRUCTURE AT AN EARTH-MOON LAGRANGIAN POINT

Abstract

Future space challenges will surely involve destinations beyond the ordinary and safe Low Earth Orbits (LEOs) and will probably foresee a wider human presence. These two aspects, connected to more harsh space environments and to the increment of time spent into deep space, will translate into more complex missions in terms of design and management, especially from the radiation protection standpoint. This paper aims to analyze different solutions to protect human beings, against radiation, influencing the system design of a four-astronaut manned habitat at an Earth-Moon Lagrangian Point (EML). The considered infrastructure is based on a NASA study. The proposed radiation shielding solutions are assumed to be applied on a rigid module (habitat) where the Crew Quarters (CQs) are supposed to be. Within the paper, the mission top level requirements are defined; they allow to successively identify the systems and sub-systems needed to achieve the mission targets. Thus a detailed computation of mass and volume of each system is performed considering an habitat both with and without water and oxygen regeneration systems. The inner geometrical dimensions of the habitat, taking also into account the optimum volume to guarantee to each astronaut, are also defined. Moreover, in order to estimate the protection provided by the structure, a reference primary and secondary structures (ISS-module like) are taken into account. At this point, it is necessary to compute the amount of areal density that shall be added to the value already provided by the habitat (4.3 g/cm2, CQs excluded). This is done with an approach that foresees a sort of detailed sectorial analysis, the schedule of a reference day of activities, and the use of two free software (SPENVIS and OMERE) to define the equivalent dose (E) to compare with a reference threshold limit (0.25 Sv), derived from dosimetry data. With the outcomes, it is possible to define different solutions to increase the radiation protection, into CQs, affecting the overall system design. Four solutions, foreseeing water and polyethylene, are treated in detail: the differences among them mainly consist in the presence of a water regenerative system and the removability of the protection itself, done by the astronauts. A trade-off among the four options is introduced, considering seven criteria, such as system reliability, mass, manufacturing costs, operational complexity and others, to define the most suitable choice.