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HABITABLE MODULE FOR A DEEP SPACE EXPLORATION MISSION

Abstract

The paper deals with the conceptual design of a habitable module conceived for long duration space exploration missions. The pressurized habitation module (HAB) has been specifically sized for a Near Earth Asteroid (NEA) mission, in the framework of the fifth edition of the International Postgraduate Master in "SpacE Exploration and Development Systems", which had as main purpose the study of a humAn Exploration mission to a Near Earth Asteroid (AENEA mission). This mission is conceived as an intermediate step before going to further destinations and aims at testing technologies necessary for reaching more challenging targets. In accordance to the mission objectives, the HAB has been devised as a reusable space infrastructure, suitable for different exploration scenarios with only minor changes in the architecture/design. The paper describes the design process that, starting from the mission statement, has been followed to define the objectives, the requirements and the architecture of the module in terms of system and subsystems configuration. In particular, the HAB has been designed to safely sustain the life of 4 astronauts, for a mission to a NEA lasting about 6 months. The main subsystems of the HAB have been sized in order to provide the astronauts with the needed resources, support the activities during all operational phases, including the EVAs on the asteroid's surface, and protect them against the external environment, with particular attention to the space radiation, one of the most critical aspects of this kind of mission. In this regard, appropriate analyses have been carried out for selecting the best shielding strategy. For the execution of the EVAs on the asteroid surface, a dedicated airlock and specific EVA support tools have been included. The paper reports a detailed description of the subsystems and their innovative aspects. Starting from the mission phases and the related scenarios, different modes of operations have been identified. System budgets have been evaluated for the envisaged operational modes. The paper illustrates both the applied methodologies and the results, highlighting the major criticalities to be faced (long exposure to space radiations, EVA operations on the asteroid surface) and the key technologies (radiation shielding, inflatable technology, EVA support tools).