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Author: Ms. Asnate Plocina
University of Leicester, United Kingdom, ap786@student.le.ac.uk

Mr. Parin Vyas
University of Leicester, United Kingdom, ppv2@student.le.ac.uk
Mr. Thomas Lovell
University of Leicester, United Kingdom, thomasdaniellovell@gmail.com
Mr. Jose Cavero
University of Leicester, Spain, jose.cavero95@gmail.com
Mr. Sedat Izcan
University of Leicester, United Kingdom, izcansedat@gmail.com
Mr. Alexander Smith
University of Leicester, United Kingdom, atps1@student.le.ac.uk
Mr. Nihar Modi
University of Leicester, United Kingdom, niharmodi21@gmail.com
Mr. Jialian Yu
University of Leicester, United Kingdom, yu1508lian@gmail.com
Mr. Joseph Robinson
University of Leicester, United Kingdom, josephrobinson98@outlook.com

LIFE SUPPORT SYSTEMS OF A TRANSFER VEHICLE AND EVA FOR A CREWED MISSION TO MARS

Abstract

In line with the Global Exploration Roadmap (GER) for the International Space Exploration Coordination Group (ISECG), a crewed exploration mission to Mars has become a major goal for space agencies internationally. To facilitate this, it is necessary to create a habitable environment with a pressurised module and similar conditions as on Earth, with a breathable atmosphere, provision of food and water, a stable thermal environment and efficient and safe waste management. The biological life support systems currently operating in space have been developed for this purpose, such as the one implemented on International Space Station (ISS). These life support systems are not fully sustainable when it comes to increased crew size and mission duration. To improve mission safety and guarantee human performance in long-term missions, such as the one to Mars, increased longevity and reliability become critical parameters in system design. The number of resources on board must be optimised and reused either through re-supply missions or in-space regeneration. This paper explores life support systems with fully and partially closed loops.

A life support system with a complete closure loop may not be practical. This type of system would require handling all loops of air reclamation, water reclamation and food production. The drawback of copying all natural environment functions on Earth into a Controlled Ecological Life Support System (CELSS) is that it is challenging to obey stringent environmental requirements, like atmospheric properties, temperature and suitable gravitational environment. For a future crewed mission to Mars, the food loop must be at least partially closed, one option being by means of growing plants from waste production. This would help to tackle the challenging and costly re-supply missions. To meet this requirement, the

system must have the properties to generate oxygen and food from carbon dioxide, whilst simultaneously creating clean water.

Details of regenerative functions, system concepts and a potential future biological life support system for a human transfer vehicle to Mars are provided. In the case of Extravehicular Activity (EVA), the life support system of the space suit is explored. In addition, trade-off analysis is performed on different life support systems in terms of their mass and suitability for the mission. A final preliminary design of life support systems is presented, alongside estimates for the typical usage of consumables on-board.