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LIFE SUPPORT SYSTEM INFRASTRUCTURE FOR FUTURE EXTRATERRESTRIAL COLONIZATION – CIRA CONCEPT

Abstract

Long-term manned spaceflight and extraterrestrial planet settlement are the recent trends of space powers and national space agencies. Among the many challenges that have to be addressed to achieve those results, one of the most complex is how to guarantee the continuous supply of life support materials, such as food, oxygen and water, in the condition that supplies are almost impossible to be provided.

Nowadays, the environmental control and life support system onboard the most advanced manned spacecraft (the ISS), can only achieve the regeneration of atmosphere and water, while food is still sent from Earth. The only strategy to overcome these limitations is to develop a Controlled Ecological Life Support System (CELSS) that, according to the principles of Earth biosphere, would guarantee the survival of astronauts for long-term manned deep space exploration missions and consequently for the extraterrestrial colonization of natural satellites and planets as the Moon and Mars. Those systems are intended to be fully enclosed and self-sufficient life support systems combining producers, consumers, decomposers and complex engineering systems necessary for environmental parameters regulation and control.

Considering this scenario, the Italian Aerospace Research Center (CIRA) is currently working at the MARS Program to enhance national skills and capabilities in testing activities related to space colonization. The program aims to develop several technologies and tools necessary for human exploration missions and to design and realize world class experimental infrastructures to support industries, universities and research centers in this challenging sector of space technology. The proposed MARS infrastructure consists of environmental chambers, a robotic laboratory equipped with a rover area, an aeolic tunnel and a Life Support System (LSS) area. The LSS area will host a CELSS infrastructure whose modularity will allow, stand-alone or integrated, experimental campaigns that could include plants, animals and humans.

After a brief overview of the international CELSS-related research infrastructures scenario, the present paper discusses the collected requirements for the CIRA LSS infrastructure, its preliminary design and the initial concept of its compartments. Finally, a description of the main sections, together with all the necessary enabling technologies to be developed and the experimental tests foreseen in each area is reported and discussed.