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MELFI REFRIGERATION TECHNOLOGY IN ISS AS IMPORTANT ASSET FOR SPACE BIOLOGY INSIDE THE LUNAR GATEWAY

Abstract

MELFI technology developed for the Space Station has shown an outstanding performance with three units used every day by the astronauts. This technology is key for the refrigeration of the specimens for life science experiments. The design has proved a huge capability of adaptation on temperatures derived from a single cold power production and in life duration. Initially targeting only -80C, the early phase design was soon adapted the other temperatures. Without impacting the heart of the cold power production, the architecture of the cold distribution was transformed to reach four separate cold volumes available to store and cool specimens at temperatures selectable between +4C to -80C. The mission duration during the development was specified for a utilization scenario where maintenance on ground was possible with a rotation of the MELFI unit between Space and Ground. This mission was soon modified during the development phase to allow extensive maintenance in orbit, as the units would definitively remain inside the ISS. Maintenance procedures were transformed for orbit and some spare equipment was added to the program to sustain the extended life duration in orbit. In orbit since 2006, 2008 and 2009 sequentially, the MELFI three units' pool has seen its life duration extended several times and is now assuming a utilization until 2030, accompanying the ISS until its last mission. With all three units working 24 hours/ 7 days, the pool is on the way to reach in 2030 a cumulated time inside ISS of 69 years, with a potential cumulated collective operational running time over 55 years. The refrigeration performance and the life duration of the MELFI units inside the ISS indicate that the technology shall be considered an important asset for the life experiments inside the Lunar Gateway science studies on fundamental space biology and human health. Keeping as much as possible the cold power production design, evolutions can be developed to modify the cold distribution, increasing or decreasing the number of necessary cold temperatures. The technology for the cold volumes could also be reassessed taking benefit of other solutions for the thermal insulation, which would bring an overall mass reduction of the facility. Other investigations for equipment as electrical power distribution and data management would further reduce the total mass of the refrigeration unit. The paper will present how the existing refrigeration design for ISS may easily be adapted for possible space biology missions inside the Lunar Gateway.