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Space Architecture: technical aspects, design, engineering, concepts and mission planning (1)

Author: Ms. Lucie Poulet

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, luciepoulet@yahoo.fr

Dr. Ondrej Doule

Florida Institute of Technology, United States, odoule@fit.edu

GREENHOUSE AUTOMATION, ILLUMINATION AND EXPANSION STUDY FOR MARS DESERT
RESEARCH STATION**Abstract**

A partially or fully autonomous food production facility is one of the most important elements in any extraterrestrial settlement. The GreenHab, the greenhouse of the Mars Desert Research Station (MDRS), provides an excellent opportunity for an expansion study, considering it both as an experimental facility for crop growth but also as a food provider for the crew. The current GreenHab is a basic horizontal cylindrical structure divided into two parts. The larger part is used for vegetables growth over the season, which are harvested and consumed by the latest crews in rotation at the station. It also provides the opportunity to perform experiments within the greenhouse facility. The second part is dedicated to the crew well-being in form of a Zen garden with flowers. The GreenHab is currently an independent module linked to the main habitat through a corridor. Full integration of the greenhouse module into the habitat would be preferable since on top of participating to food production it could also contribute directly to air revitalization and water recycling, which are processes directly related to human operations in the base. The MDRS internal environment suffers from extremely low humidity due to its location in the high desert of Utah and also due to its heat and ventilation air conditioning system design that is not integrated with the other base subsystems. An integrated greenhouse could improve the atmosphere quality and decrease crew health risks as well as increase their comfort and work efficiency. Greenhouse systems are not hazardous (in opposition to some power systems requiring specific distance from the base due to possible life endangering failures) and thus do not require protective zoning apart from the habitation unit, which makes their integration into the habitat a plausible scenario. This paper presents number of approaches and options for the GreenHab automation, illumination and capacity expansion based on various research, production and base operations interests. Currently the GreenHab requires much crew time for maintenance and daily operations, which could be reduced by at least one third using automation techniques. The use of supplemental lighting would also greatly improve light conditions inside the GreenHab, therefore enhancing crop growth and yield of the greenhouse. There are numerous options for the GreenHab expansion such as: modular, dome radial, detached, attached from pre-fabricated components, self-deployable or built of in-situ resources depending on the level of habitat and greenhouse simulations and structures fidelity.