Argus Controls: Aiming for the stars

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EDEN ISS is a four-year project created by the European Union's Research & Innovation Programme Horizon 2020 in which researchers aim to address the supply of food for long-term missions to outer space with innovations in cultivating food in closed-loop systems. Private and public organizations from around the globe have teamed up to advance controlled environment agriculture technologies beyond the state-of–the-art. The EDEN ISS consortium is comprised of leading experts from Europe, Canada and the USA in human spaceflight and controlled environment agriculture. The EDEN ISS scientific advisory board consists of the top scientists in the field from Russia, USA, Japan, Italy and Germany. Argus Controls has been selected as the controls system for this greenhouse test facility that will demonstrate the technologies and procedures necessary for food production in closed environments located in extreme outside conditions.

The EDEN ISS Project

Plant cultivation training at Wageningen University

In 2011, DLR's Institute of Space Systems launched its research initiative EDEN (Evolution and Design of Environmentally-Closed Nutrition-Sources). In March 2015 EDEN ISS project saw the light with funding from the Horizon 2020 Research & Innovation Programme.

During the first year, the team spent most of its time in the laboratory working with different growth chambers simultaneously while running test trials with lettuce and cucumbers. In the latter part of the year, tomatoes were introduced to the mix. By November 2015, the test trials for the growth chambers associated directly with the EDEN ISS project commenced.

In 2016, the team continued to conduct experiments in the EDEN Lab testing for potential plant growth in Antarctica and space. Important improvements to the system were accomplished and the EDEN team along with their EDEN ISS partners were able to select crops to be taken to the Antarctic mission. Another two relevant achievements in 2016 included confirmation of performance of the prototype LED lamps in the test growth cycle and continuation of experiments on the urine-based nutrient solution for the DLR Institute of Aerospace Medicine led CROP (Combined Regenerative Organic Food Production) project. Other key milestones in the program were the critical design review as well as the project approval by the German Environment Ministry allowing the first shipment of EDEN ISS hardware to Antarctica. The Mobile Test Facility (MTF) was built in 2016 as well. During October of that year, the two containers of the MTF were delivered to Bremen; after being installed, the power system was integrated and the Argus control system – for control and data handling- came next. Conrad Zeidler, responsible for monitoring and controlling the plant and environment parameters within EDEN, explained: "The EDEN ISS Mobile Test Facility consists of two 20 foot high cube containers, which will be placed on top of an external platform located approximately 400 m south from Neumayer Station III. The MTF can be subdivided into three distinct sections the Cold Porch/ Airlock, the Service Section and the Future Exploration Greenhouse." All three different sections of the MTF include state-of-the-art technology specifically designed for the EDEN ISS project:

Cold Porch: The cold porch is the entrance area to the MTF and serves as a buffer zone, separating the Service Section from the external environmental conditions. It includes a number of air management components and sections of ducting, located above the storage cabinet and along the ceiling, which provide fresh air from the external environment to the Service Section.

Service Section: The Service Section houses the majority of the MTF subsystem components, as well as the International Standard Payload Rack (ISPR) plant cultivation system. The main ISPR structure is composed from Bosch Rexroth aluminum profiles to favor implementation of multiple configurations in the rack development process and includes an illumination system which relies on water cooled LEDs. The ISPR includes: an Atmosphere Management Subsystem and Thermal Control Subsystem which contains a temperate and humidity control system; a major constituents control system to manage the environmental pressure and O_2 and CO_2 concentrations; a nutrient delivery subsystem for nutrient storage and distribution; a subsystem for command and data handling; and a power distribution and control subsystem. The Service Section provides working space for the crew and will include the cable and pipe interfaces to the exterior of the MTF.

Future Exploration Greenhouse: It includes eight multilevel growth racks used to cultivate the selected crops of the EDEN ISS project. Each rack contains two growth trays per level, up to a maximum of eight growth trays per rack. A total of 40 growth trays can be placed at a time. A pantographic system attached to this platform allows for vertical movement of a tray with observation cameras.

In October 2017, the EDEN ISS Mobile Test Facility will be shipped from Bremen, Germany to Antarctica where it will arrive in December 2017 where the setup and commissioning crew will be ready to begin the assembly of the MTF. The EDEN ISS overwintering crew member will begin his four-month training in August 2017.

2018 will be the year in which the nine-month isolation overwintering period will occur. To be ready for this very important turning point, the facility will need to be fully operational by January in order to commence with the experiment and validation campaign. Once the isolation period has begun, it is expected to have the first harvest of grown crops by April and a full salad bowl with vegetables grown in the facility by June. In November, the isolation period will come to an end and by December 2018 the Antarctic experiment campaign will be completed.

The EDEN ISS project includes the following project partners: German Aerospace Center, LIQUIFIER Systems Group, National Research Council (Italy), University of Guelph, Alfred Wegener Institute, Enginsoft, Airbus Defense and Space, Thales Alenia Space Italy, Arescosmo, Wageningen University and Research, Heliospectra, Limerick Institute of Technology, Telespazio and University of Florida.

Argus Controls role in the project

Operation techniques for higher plant cultivation to achieve reliable and safe production of high-quality food; microbiological behavior and countermeasures in plant-based closed ecosystems; adaptation, integration, fine-tuning and demonstration of key technologies; and integration of key technologies in an International Standard Payload Rack - like system and in a Future Exploration Greenhouse are amongst the primary objectives of the project. In order to achieve those goals with a reliable controls system, the EDEN ISS team selected Argus Controls.

Inside the MTF

When referring to the Argus systems, Zeidler remarked: “Nearly all of the monitoring and automated controlling tasks are performed by the Argus Control System, which is connected to the bulk of the sensors and actuators in the MTF.

Control subsystem box from Argus Controls (left side) and power distribution cabinet (right side).

The designed Argus hardware is an essential component for handling the wide range of tasks needed in the Future Exploration Greenhouse. With the help of the Argus hardware and software solutions, it will be possible to manage all data and ensure storage and remote access/control of the MTF from the Neumayer Station III and from the various User Home Bases located in the EDEN ISS control centres distributed throughout Europe and North America. The data stream to the User Home Bases is composed of data from approximately 117 sensors and 87 actuators.”

Argus Controls was recommended for this project by the Controlled Environment Systems Research Facility (CESRF) at the University of Guelph. CESRF joined DLR and the other partners to contribute to the design, construction and operation of EDEN ISS; the University of Guelph main task has been to develop the nutrient delivery system and to assist in the control system integration. Dr. Michael Stasiak, a researcher from this renowned institution and a user of Argus Controls since 2001, was the main intermediary between Argus and this DLR initiative back in 2015 and has been closely involved in the part selection and the design to incorporate the controls to the facility as well as constantly following up on every step of the way. Dr. Stasiak has described Argus Controls as “extremely reliable” and stated: “Argus provided a unified approach so that each subsystem was controlled and data-logged […] Argus hardware is easily adapted to the plethora of sensors and actuators required in a scientific installation such as this.”

References

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