
# Status Update

prepared for

**WP 1.1 – Project Office**

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**Approved by:** Daniel Schubert [WP 1.1] Work Package Leader

**Approved by:**

**Approved by:**

**List of Authors:**

| Participant No. | Short name | Author name(s) |
|---|---|---|
| 1 | DLR | P. Zabel, D. Schubert, M. Bamsey, C. Zeidler; V. Vrakking |
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# TOPICS

## Topic 1: Organizational Aspects & Status

The EDEN ISS project has finally completed its AIT phase in Germany. The deployment team is now in the wild phase of preparation. The official start of the analogue mission will be the 19th of December with an arrival of the containers in Antarctica on the 24th of December (as a X-mas gift)! ☺

Here are some organizational aspects and status items that we wish to address:

- The MTF test phase has been successfully completed and multiple growth cycles and harvest events have taken place across various cultivars from May to September 2017. Certain challenges occurred during the testing phase such as nutritional imbalance in the crop cultivars, AMS condensate leaks, ISPR functional problems, microbial and fungal growth in the NDS tanks and pipes, and leakage problems in some pipes. These were addressed and dealt with rapidly. Further measures were also taken to better ensure that these situations will not arise again. The actual deployment will give us more opportunities to test the systems.
- The FRR was completed. There are still some open RIDs and the help of the partners is needed. Matt is taking care of this. Please report to him with respect to answering all open RIDs. The payment from the EU was shifted due to some financial issues and open questions. We hope to submit the new version by the end of November.
- We now have an Acknoldegements section on the main project website. Here, involved companies and accoicated partners can be named. If you have such an partner, please send a short decription (2-3 sentences), a compnay logo, offical web site link, and a specific picture of the activity or the prodcut that was developed/build by that company to Daniel. We will then put this achmowledgement note on the EDEN ISS website.
- Please send Daniel all planned conferences for 2018. Please note the AGROSPACE 2018 (Italy) conference. The EDEN ISS consortium should hand in presentations, as soon as the call for papers is online. The theme for this event is: “Current and future ways to Closed Life Support Systems”. It will be a joint meeting with ESA’s MELiSSA Group. Location: Rome, main building of CNR (May, 16-18th 2018).
- The official animation video will soon be ready to be downloaded. An announcement for that will circulated soon by LSG. Further, a set of official pictures of the AIT and the testing phase will be distributed. You can use these pictures for outreach purposes or conference presentations.
- Soon, we will send out a data package containing pictures of the MTF that you can use for press releases or publications.


Figure 1: The MTF window cover, with the logos of all the partner companies, and signatures. NOTE: This is a collage, meaning the logos were put in the picture afterwards!

## Topic 2: Flight Readiness Review (FRR)

In June, the EDEN group hosted its last international meeting of all partner organizations before the start of the Antarctic campaign. In total, 50 researchers were welcomed at DLR in Bremen for 3 days of deliberations about final mission operations, discussion about ongoing issues with the project and for a tour of the container. Overall the FRR raised 131 RIDs varying the spectrum from technical to science to operational related.

This productive meeting followed up on the Critical Design Review in 2016 and the Concurrent Engineering Meeting in 2015. We now look to implement the most scientifically evolved strategy the mission has had, derived from recommendations via the Scientific Advisory Board.


Figure 2: FRR participants

Figure 3: Colleagues from the FRR inspecting the Service Section (left) and the FEG (right)

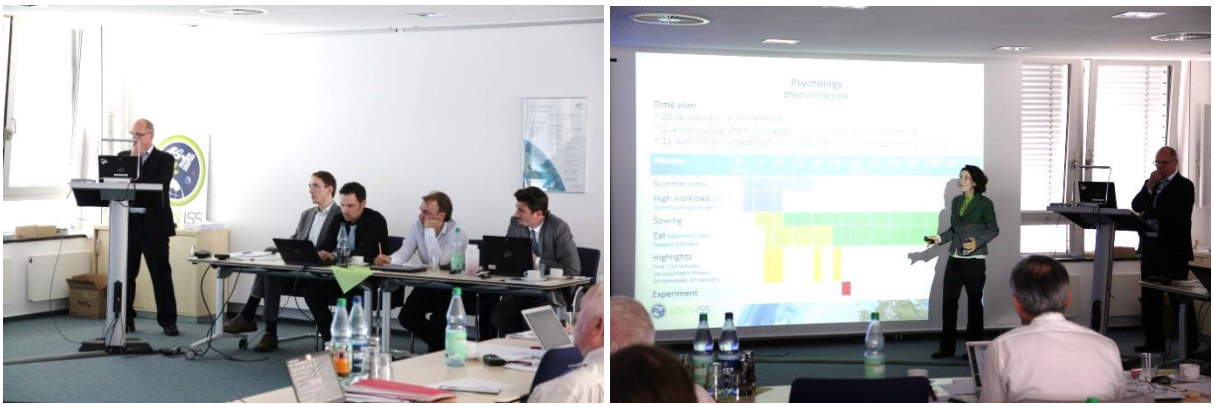


Figure 4: Presentations given in the FRR


Figure 5: EDEN ISS team members explaining to FRR board members the AMS (left) and the FEG (right)

## Topic 3: Mobile Test Facility Final Test Phase

Full operations of the MTF occurred until September 4, 2017 when the plants were removed from the FEG. Several tests and subsystem shut down activities continued following this date but the FEG and Service Section containers were separated on September 13, 2017.

Overall, the EDEN ISS assembly, integration and test (AIT) phase brought about a number of lessons learned that will improve operations in Antarctica. Several subsystem modifications were implemented, the operations software was improved, the scientific protocols were trialed and training conducted, the nutrient solution recipes adjusted slightly and the camera systems and the data management pathways further developed.

The operations phase also permitted several tests to be conducted including, acoustic measurements, FEG leakage assessment, food safety laboratory results (all passed the initial project require-

ments), measurement of condensate production, as well as laboratory confirmation of food safety of several of the harvested crops. The AIT phase also permitted a wide range of outreach activities to be conducted on-site at DLR (e.g. official press conference, high-level visits of NASA and others).


Figure 6: The EDEN ISS MTF nearing the end of the AIT phase

Figure 7: Service Section during the end phases of the ground tests

Figure 8: FEG plants in full bloom, right before a harvest cycle


Figure 9: Final harvests during ground tests, used for sampling and analysis of safety for consumption

Figure 10: Final ground test harvests (left). Tomato plants in growth phase, with some ripe fruits (right)

**Topic 4: Mission Preparation and Packing**

For testing the MTF's ability to remain sterile despite external factors, the MTF had to be cleaned and sterilized to the greatest degree possible. To ensure that any microbial or fungal growth might occur is not due to any leftover cells from ground tests but as a result of external contamination, the container was sterilized and sealed.

To meet the project's science and operational goals a third 20 ft. shipping container was provided by AWI to be used both for the transport of EDEN ISS supplies, but also to serve as an external storage location for the project during the Antarctic operations phase. This 'blue' container can be seen in the images to follow. During the deployment phase it will also function as a mobile workshop. The packing of this blue container as well as the other MTF containers was a significant effort based upon the amount of project hardware and consumables. In particular, in the lead up to the packing phase, the project reassessed priority replacement parts for the overall MTF and acquired a significant number of such replacement parts to further reduce the risk that any failure during the Antarctic operations phase can negatively influence the overall project.

The main effort of the EDEN ISS packing activities involved over 138 distinct items, of which the bulk were large aluminum boxes filled with an assortment of supplies. The organization of the dangerous goods also involved a significant effort on part of the DLR and a shipping company due to the nature of the wide array of chemicals from nutrient salts, to cleaning chemicals to building supplies. The team also prepared for an export control inspection. The final step of the packing activities involved a professional packing company.
An initial requirement of the project was that the MTF containers be below 10 tons so as to ensure they do not reach the limit of the cranes on-site at NM-III which will be used to load the containers on the elevated platform. The table below shows the container masses at the time of shipment to Antarctica. Due to relatively high weight of the Service Section container, no project boxes were packed inside.

**Table 1: Table showing the containers' mass and transport status**

| Container | Mass | Date of container pickup for shipment to Hamburg |
|---|---|---|
| Service Section Container | 9.6 tons | Best weight for empty Service Section container. Includes all drawers installed in the ISPR (except NDS). Floor panels still installed. All water tanks empty. Container in shipping state (no boxes installed). The only difference from the Sep 13, 2017 mass is that more water was emptied from the piping, water heater etc., the shipping wall was installed on the container interface and the window protector was installed on the window. |
| FEG Container | 8.5 tons | Container in shipping state but includes boxes shipped to Antarctica within the FEG (see FEG freight list). |
| Blue Transport Container | 6.2 tons | Mass following the locking of the container doors (i.e. contained all boxes listed in the blue container freight list). |

Due to temperature sensitivity, cost and order lead-time factors several other EDEN ISS shipments also were prepared. One shipment is departing on the Polarstern and arrive at NM-III nearing the end of January 2018. Two other shipments were prepared that will be travel from Cape Town to NM-III on the same put-in plane as the initial EDEN ISS field team members.

Figure 11: Sample Preparation for food safety tests (left). Preparation of nutrients and other dangerous goods to be taken to Antarctica (right).

Figure 12: Cleaning, sterilizing and packing FEG and Service Section for transport

Figure 13: Project hardware during the packing of the EDEN ISS containers

Figure 14: The EDEN ISS blue transport container as packing continued

## Topic 5: Container Shipment

The three EDEN ISS containers were picked up from DLR Bremen on October 2nd. At this time they were loaded onto two different trucks and driven to Hamburg where they were eventually loaded onto a container ship (Golden Karoo) destined for Cape Town. Upon reaching Cape Town the containers will be loaded onto the SA Agulhas II (South African research vessel) and be transported to the Neumayer Station III. The estimated arrival of the SA Agulhas II at Neumayer is Dec 24, 2017.

Figure 15: Transport of the MTF to Hamburg, and loading into Golden Karoo


Figure 16: Loading of one of the EDEN ISS container onto the Golden Karoo in Hamburg


Figure 17: Unloading of one of the EDEN ISS container in Cape Town date: ~6th of November 2017

## Topic 6: On-Site Field Plan @ Antarctica

The EDEN ISS project is now entering the Antarctic demonstration phase. The table below presents several of the top-level on-site activities that will occur during the 2017-2018 Antarctic summer field season.

**Table 2: MTF site installation itinerary**

| Date | Activity |
|---|---|
| **Dec 19** | **First part of EDEN ISS field team arrives at NM-III (D. Schubert, M. Bamsey, P. Zabel, C. Zeidler and two camera team members)** |
| **Dec 24** | **Arrival of EDEN ISS containers (FEG, Service Section and storage container) at NM-III (traveling on SA Agulhas II)** |
| **Dec 26 – Dec 28** | **Installation of EDEN ISS containers onto external platform** |
| **Dec 29** | **Main MTF power connection established, other integration activities on-going** |
| **Jan 3** | **Installation of external hardware complete** |
| **Jan 6** | **Argus system powered up, subsystem activation commences** |
| **Jan 12** | **Arrival of second part of EDEN ISS field team (E, Kohlberg, R. Ferl, A.-L. Paul, G. Boscheri), seedlings brought into FEG and other seeds germinated** |
| **Jan 25** | **MTF fully operational** |
| **Feb 7** | **Departure of field team from NM-III** |

*Please note that the list dates are only projected dates and can change. A full detailed field plan schedule will also be distributed in the coming weeks.*

## Topic 7: Salad Box

The Salad Box is a small plant growth unit that will be placed within the Neumayer Station III, which uses a hydroponics system to grow 'BottleCrops'. The purpose of the Salad Box will be to have a hydroponic test set-up, and provide fresh lettuce for the crew of the station. The nutrient-rich water ensures that once the seeds have been planted, minimal interaction of the crew will be required.

The Salad Box has a 2-shelf structure, in which 48 bottles can be kept, each bottle capable of growing one plant. The bottles are placed in rows of four, on trays that can be pulled out, for ease of access.

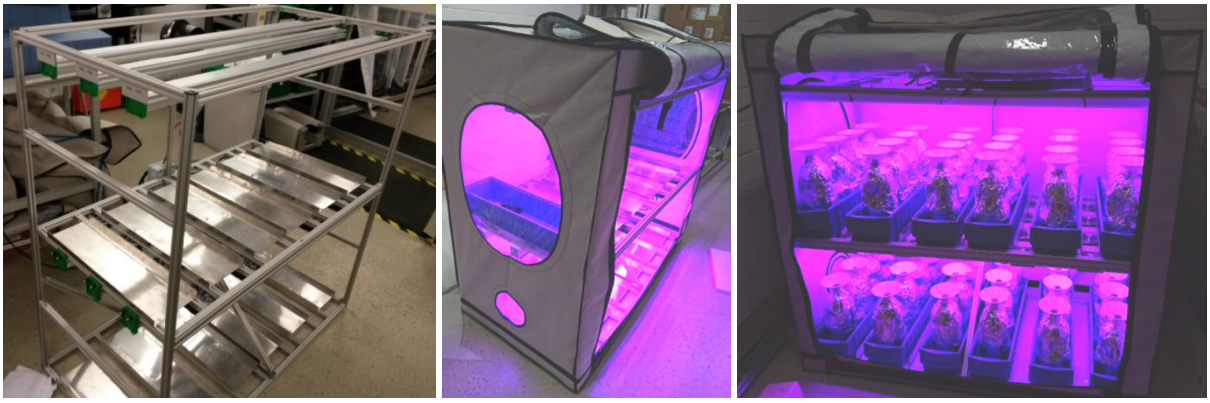

Figure 18: Salad box. (Middle and Right pictures, courtesy of Andres Leudeke)

The Salad Box has three dimmable LED bars for each shelf, and fans which actively manage air flow. The light intensity for each shelf can be controlled independently, so that various tests can be carried out. The fans are connected to a sensor/controller box which measures the temperature within the box and adjusts air flow rate accordingly. Settings for the temperature can be manually adjusted by

the researcher. Furthermore, the height of the shelves can be adjusted, by moving the top shelf. This will give the researchers a little extra leeway with the types of lettuce that can be grown.

## Topic 8: Ion Selective Optrodes

In order to achieve a completely self-sufficient BLSS; an array of accurate, robust and reliable sensors must be deployed throughout the various subsystems to maintain atmospheric and other set-points and optimize crop growth. Ion-selective optrode sensors, built by the University of Guelph and their research partners, give the user the ability to measure the concentration of a single ion in solution near-instantaneously. In the context of a BLSS, the solution will be the nutrient supplemented water that is given to the plant roots.

The ion-selective optrode sensor is essentially a fiber optic cable, suspended in a 3D sinter-printed titanium housing with two optical connectors on each end of the fiber. The optical fiber is coated in a polymer film that includes a precise mixture of four main components; an ionophore, chromoionophore, plasticizer (dioctyl sebacate) and a polymer matrix (polyvinyl chloride).

The calcium optrodes were trialed during the EDEN ISS AIT phase in Bremen. The optrode calculated hydroponic solution calcium concentrations were compared with HPLC results and allowed the team to garner several lessons learned and make several enhancements to the optrode system prior to shipment to Antarctica. The team has also been in contact with CleanGrow and acquired an updated six-ion ion selective electrode that will be employed on an opportunistic basis in Antarctica. The collaboration with CleanGrow also provides benefit due to CleanGrow's involvement with the other EC funded Horizon 2020 life support project, TIMESCALE.

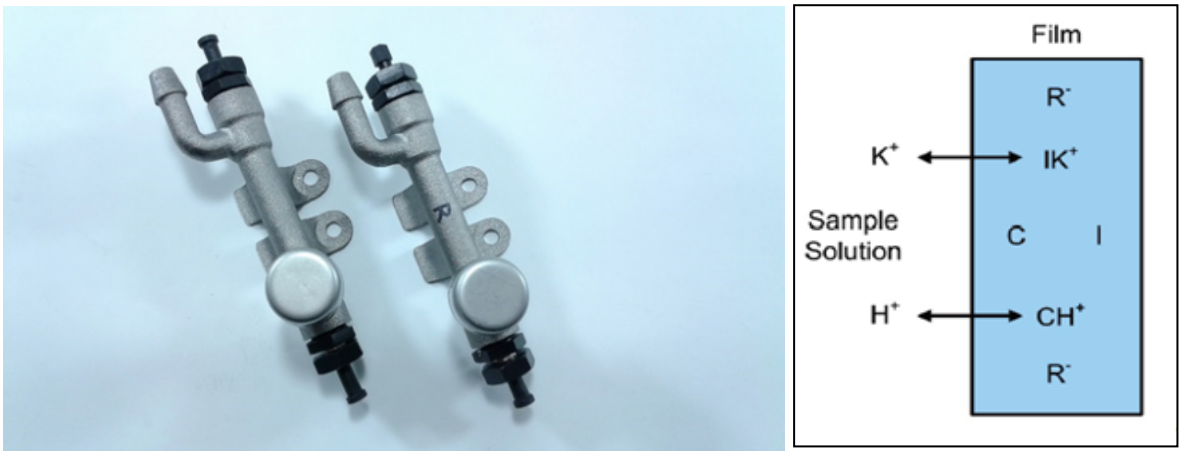


Figure 19: Current optrode housing (3D sinter-printed titanium) (left), Membrane exchange of potassium (representative) (right)

## Topic 9: IAC 2017 – Adelaide, Australia

An additional 1:15 scale mockup of the EDEN ISS facility was also presented at the DLR exhibition stand. Conrad Zeidler and Vincent Vrakking attended IAC in order to present the exhibit and explain the project to conference attendees. The pictures below show Prof. Dr. Pascale Ehrenfreund, head of DLR, examining the EDEN ISS exhibit.

English twitter message from Conrad:

https://twitter.com/DLR_en/status/912524069114847232

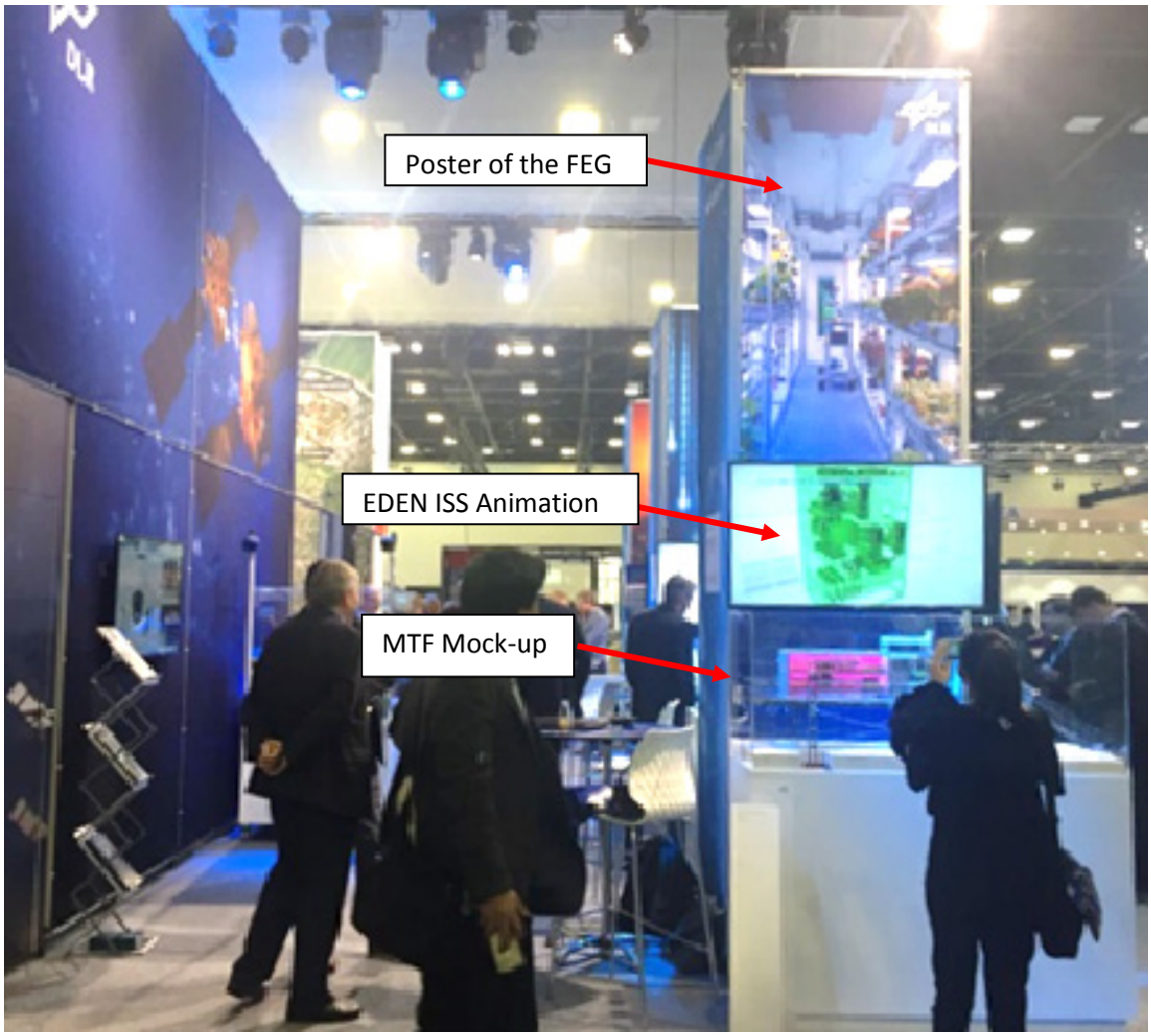


Figure 20: The EDEN ISS stand at the IAC 2018


Figure 21: Conrad and Vincent presenting the stand at the IAC 2018 to Prof. Ehrenfreund (Head of DLR)