Update on NASA Life Support Technology Research and Development

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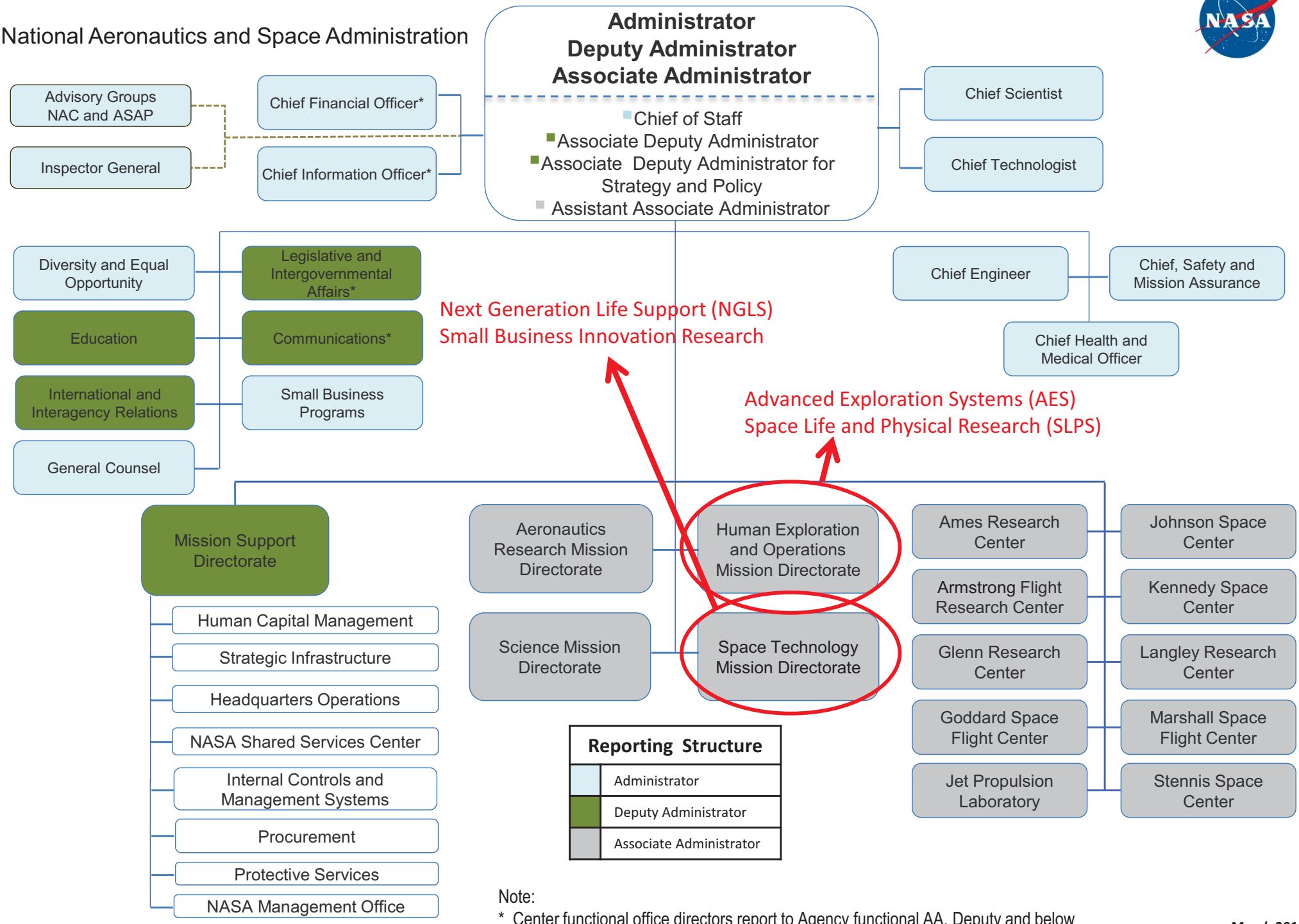

Note:
* Center functional office directors report to Agency functional AA. Deputy and below report to Center leadership.

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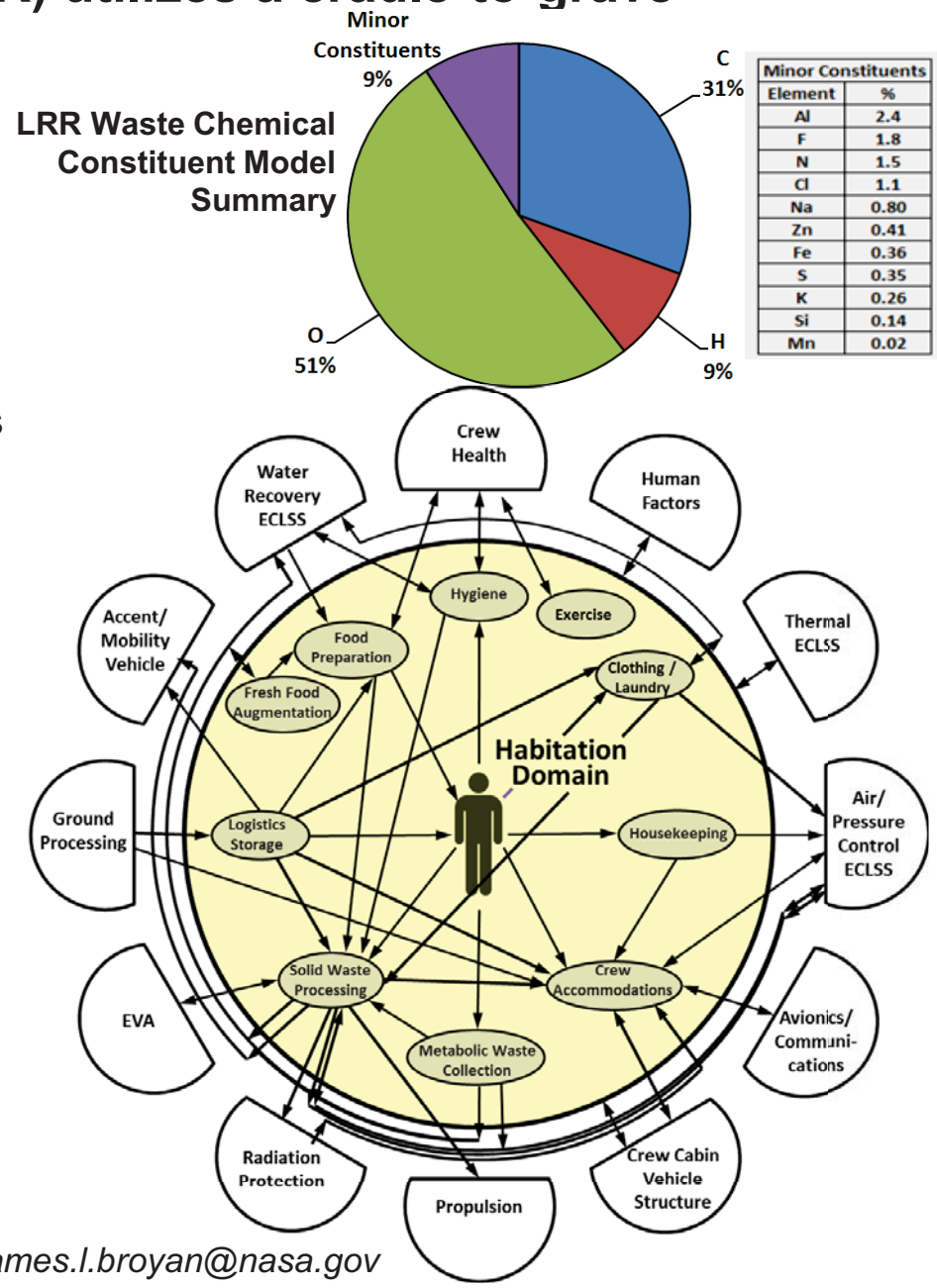
AES Logistics Reduction and Repurposing (LRR)

- **Logistics Reduction and Repurposing (LRR) utilizes a cradle-to-grave approach to reduce total logistic mass**
  - Waste should be considered a resource!!!
- **Six technologies being developed**
  - Direct reduction of logistical mass
    - Advanced Clothing Systems (ACS)
    - Universal Waste Management System (UWMS)
  - Direct reusing and repurposing of logistical items avoids flying separate items to meet both functions
    - Logistics to Living (L2L)
  - Reduce crew time on logistics tasks
    - Autonomous Logistics Management (ALM)
  - Reprocessing of logistical items to provide a secondary function, increase habitable volume, and enhance life support closure
    - Heat Melt Compactor (HMC)
  - Deconstruction of logistical wastes and reconstruction to primary gases or vented to reduce waste volume
    - Trash to Gas (TtG)



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AES Water Recovery Testing

- **Cascade Distiller System (CDS)**

  Objective: Advance the technology readiness level (TRL) of the CDS by testing its performance with flight-like waste streams and define a flight compatible design for the CDS.

- **Brine Water Recovery**

  Objective: Evaluate in-house (ARC and JSC) developed and SBIR Phase II brine dewatering technologies for applicability to an exploration mission architecture. Explore mitigation of common roadblocks associated with brine dewatering in a microgravity environment, including reliable operations and safe handling and disposal of the remaining brine solids.

- **GreenTreat Formula Optimization**

  Objective: Identify and evaluate low-toxicity wastewater stabilization (LTS) alternatives while maintaining the stabilization functions of preventing urea hydrolysis and microbial growth.

- **Silver Biocide**

  Objective: Identify methods for adding silver biocide to water on-orbit during both operational use and dormancy, as well as methods to maintain silver concentration in stored water.

- **Water Recovery Systems Analysis:**
  - Long-term dormancy assessment, Exploration Water Recovery System architecture study, Advanced Controls

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AES Atmosphere Resource Recovery & Environmental Monitoring (ARREM)

The ARREM Project is supported by 6 NASA Centers (ARC, GRC, JPL, JSC, KSC and MSFC)

KSC - Sorbent characterization & Ammonia Reduction
MSFC - Redesign of the TCCS

JPL
JSC
MSFC
ARC

ARC- Reduction of desiccant bed size

MSFC – SOA OGA Improvements & SBIR High Pressure Electrolysis
JSC – Oxygen Compression

Trace Contamination Control*

Environmental Monitoring*

Gas Drying*

CO_2 Removal*

O_2 Generation

O_2

H20

H_20

H_20

ARC - Two stage CO_2 compressor
KSC - Sorbent Characterization
MSFC - CDRA Improvements & Sorbent Characterization

GRC - Design and testing of cabin filters

HyPA

$C_2H_2 + H_2$

CH_4

Resource Recovery

CO2 Compressor

JSC - Gas Compression & Storage (CO2 & Oxygen)
MSFC - PPA, HyPA & Alternative Technologies

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Next Generation Life Support (NGLS) – NASA Space Technology Mission Directorate

The Problem

- Current life support systems are only partially closed, require resupply, cannot treat all waste streams, use toxic chemicals and are sensitive to fouling.
- EVA systems contain duration limiting hardware and have limited flexibility across missions. Issues of glove mobility, fit, and durability need to be addressed to meet performance challenges of exploration missions.

Current NGLS Activities:

- **Rapid Cycle Amine**
  - Dual function: removes both CO_2 and humidity from the atmosphere within pressurized space suits.
  - Because it regenerates in real time, it will not limit the duration of extra-vehicular activity.
  - Reduces mass and complexity of the suit by eliminating condensing heat exchangers and separators.
- **Variable Oxygen Regular**
  - Continuous control of suit pressure provides increased safety, operational flexibility & mission flexibility.
  - Robust and tolerant of contamination. Designed to withstand combustion events.
- **Alternative Water Processor**
  - A “green” choice for spacecraft water recycling, treats a wider range of wastewater types and exploits natural biodegradation to mineralize organic and nitrogen compounds in wastewater.
  - The system is capable of treating a complex wastewater stream that includes urine, condensate, hygiene water (including hand wash and shower), and laundry.
- **Advanced Oxygen Recovery**
  - Further closure of atmosphere revitalization through Bosch carbon dioxide reduction
- **High Performance EVA Glove**
  - Generate quantitative standards for glove performance for exploration class missions
  - Develop high performance EVA gloves addressing fatigue/injury, mobility, fit, and durability

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Veggie Vegetable Production Unit

Pillow Rooting Concept

- Wicking surface
  - Allows passive wicking from reservoir
- Media inside
- Fertilizer
  - Time release
- Single use - fills with roots

Veggie Facts

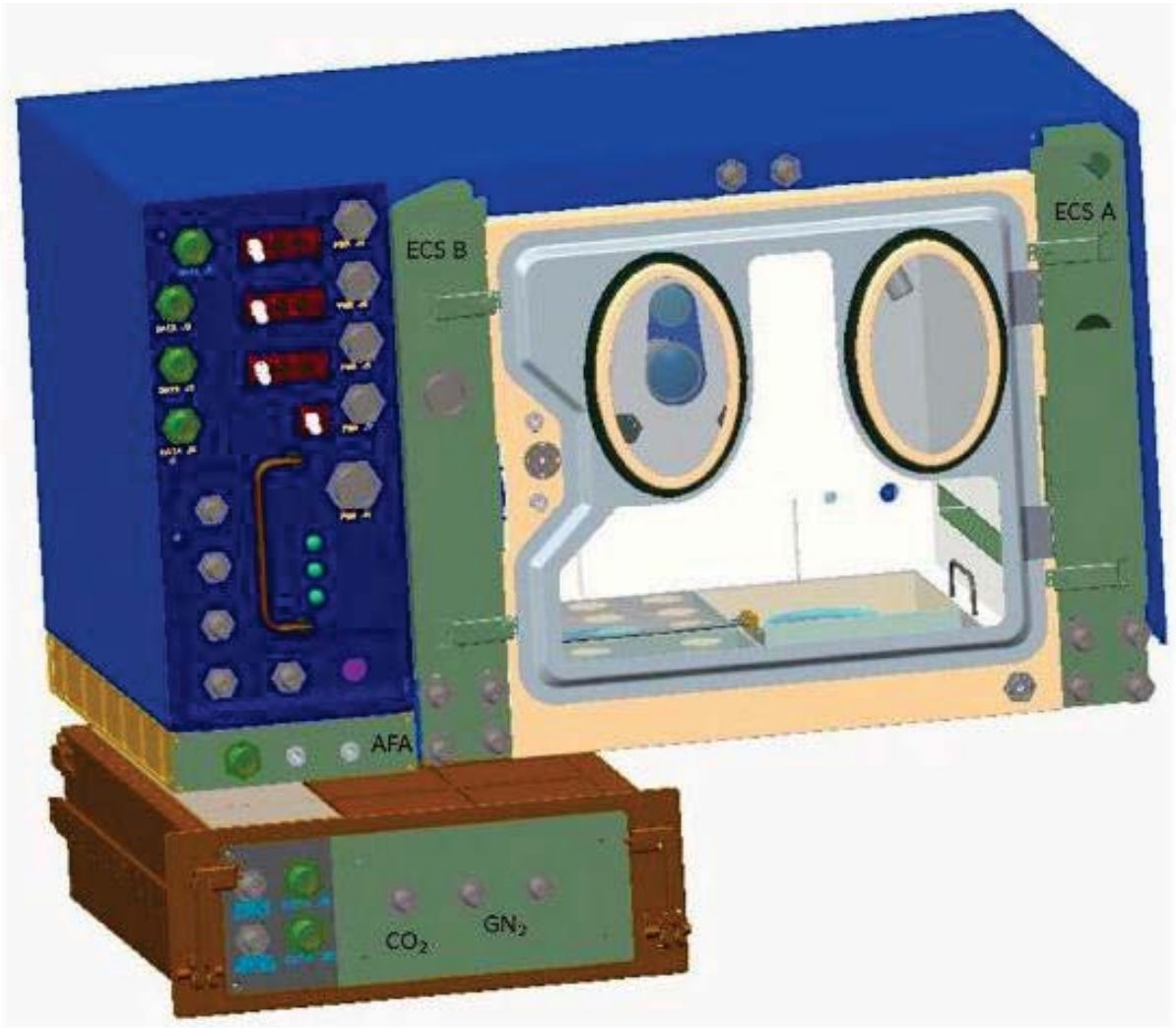
- Small Vegetable Production System – 0.15 m^2 growing area
- Compact stowage, low launch mass
- Low energy usage –lights and fans
- Minimal crew time
- Separate components allow for reuse or replacement
- Flying to ISS on SpaceX-3

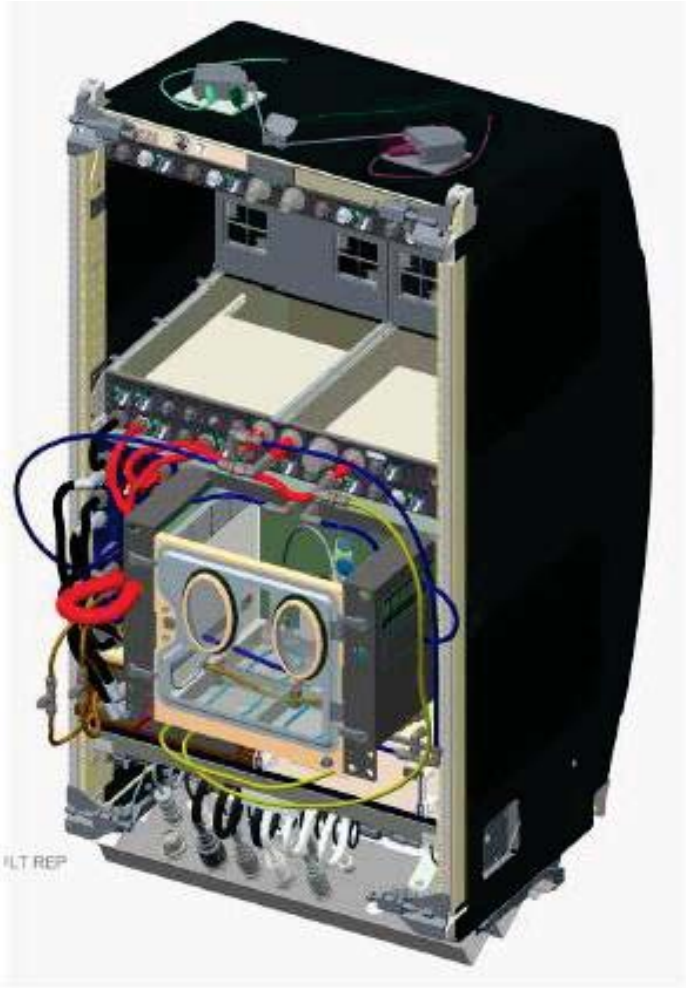
VEG-01
Hardware Verification Test - Goals

- Demonstrate hardware function on ISS
- Test procedures for Veggie operation
- Demonstrate plant pillow concept
- Compare two rooting media
- Look at microbial growth on plants, in pillows, and on surfaces
  - Food safety
- Assess plant productivity and health
- Generate data for future Veggie researchers

VEGGIE is designed and built by Orbital Technologies Corporation (ORBITEC), Madison, WI, USA

Advanced Plant Habitat – APH





Chamber slides out 10” from
The main unit for viewing
Through the top window.

Advanced Plant Habitat Specifications

- **Growth Light Assembly:** 0-1000 µmol m^{-2} s^{-1} PAR in increments of 50; Red (630-660 nm); Blue (450±10 nm); Green (525±10 nm); White (LED); Far Red (730 nm)
- **Uniformity:** ±15% (15 cm below GLA, 5 cm in from wall)
- **Temperature:** 18 C - 30° C (±1° C)
- **RH:** Controlled / monitored: 50-90% (±5%)
- **CO_2:** Controlled / monitored: 400 ppm-5000 ppm (±50 ppm or 3%)