

National Aeronautics and
Space Administration



MSFC ECLSS Overview

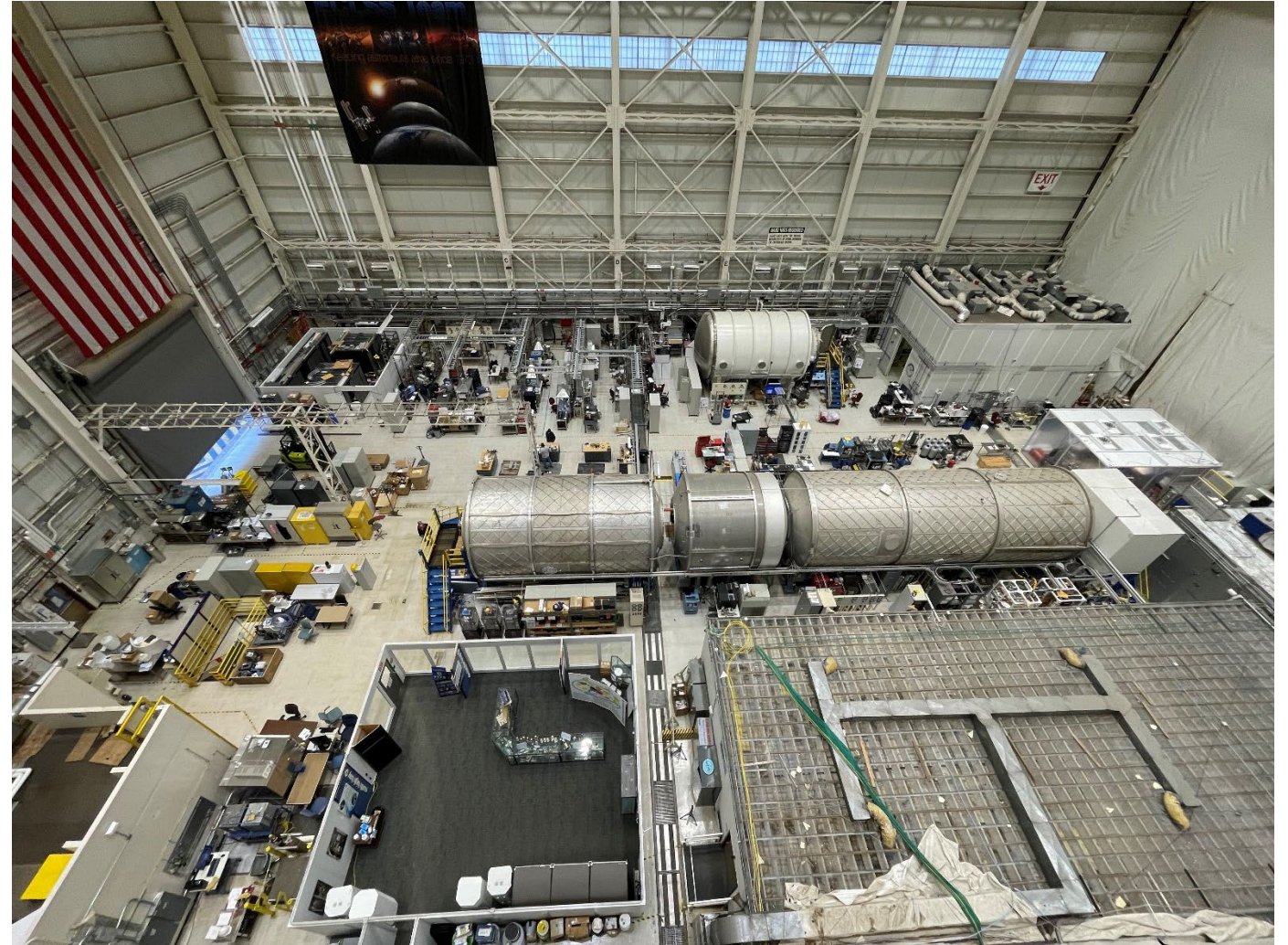
Paul Hintze, Paul.E.Hintze@nasa.gov

NASA MSFC, Chief ECLSS Branch

October 24, 2023

MSFC ECLSS: What do we do?

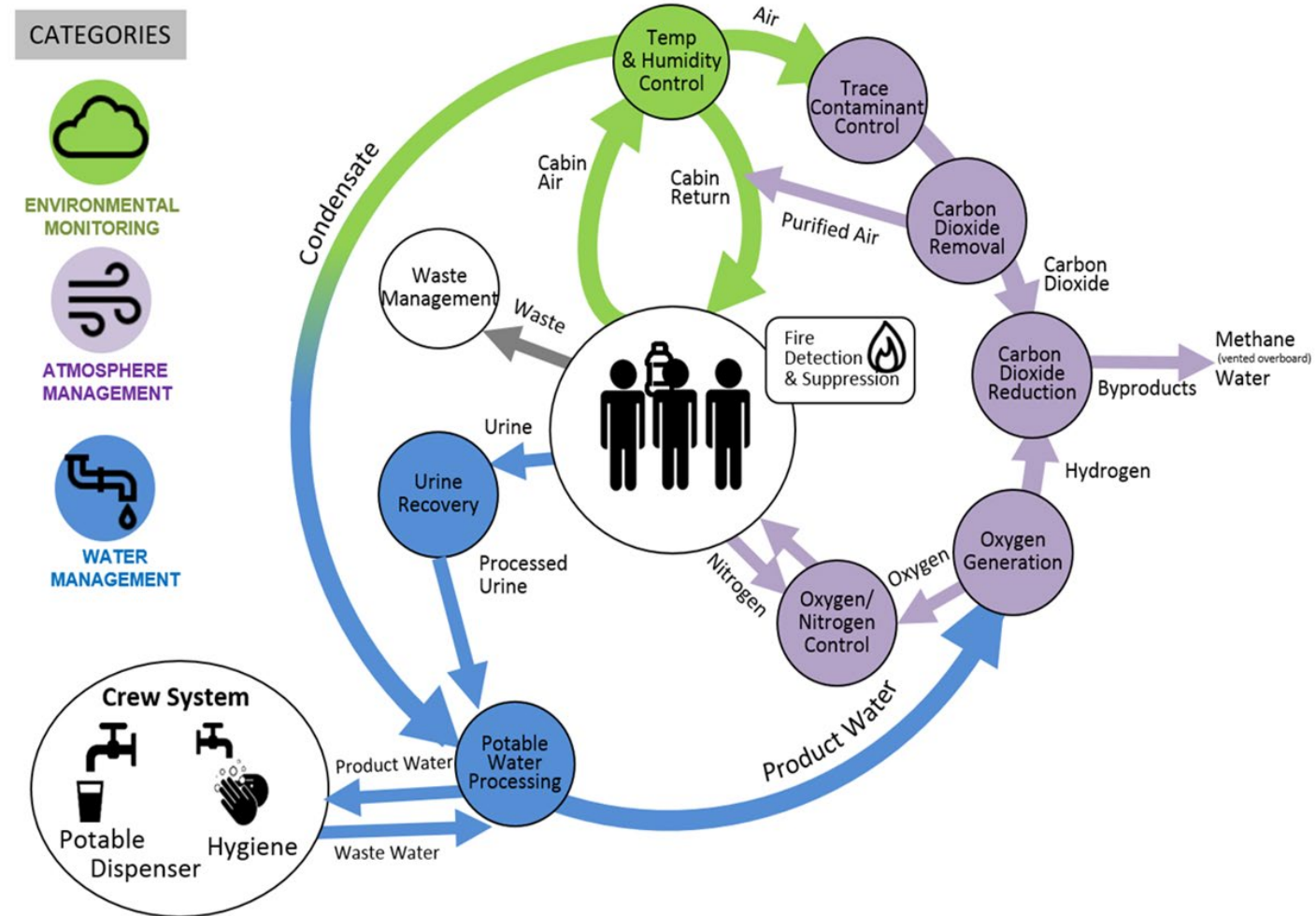
- ISS ECLSS Sustaining
- Spares and Upgrades
- Integrated Ground Testing
- ECLSS Technology Development



The MSFC ECLSS High Bay containing UPA, OGA, 4BCO2 ground units, chambers for closed door testing, and areas for new technology development.

ECLSS Environmental & Monitoring Technology Areas

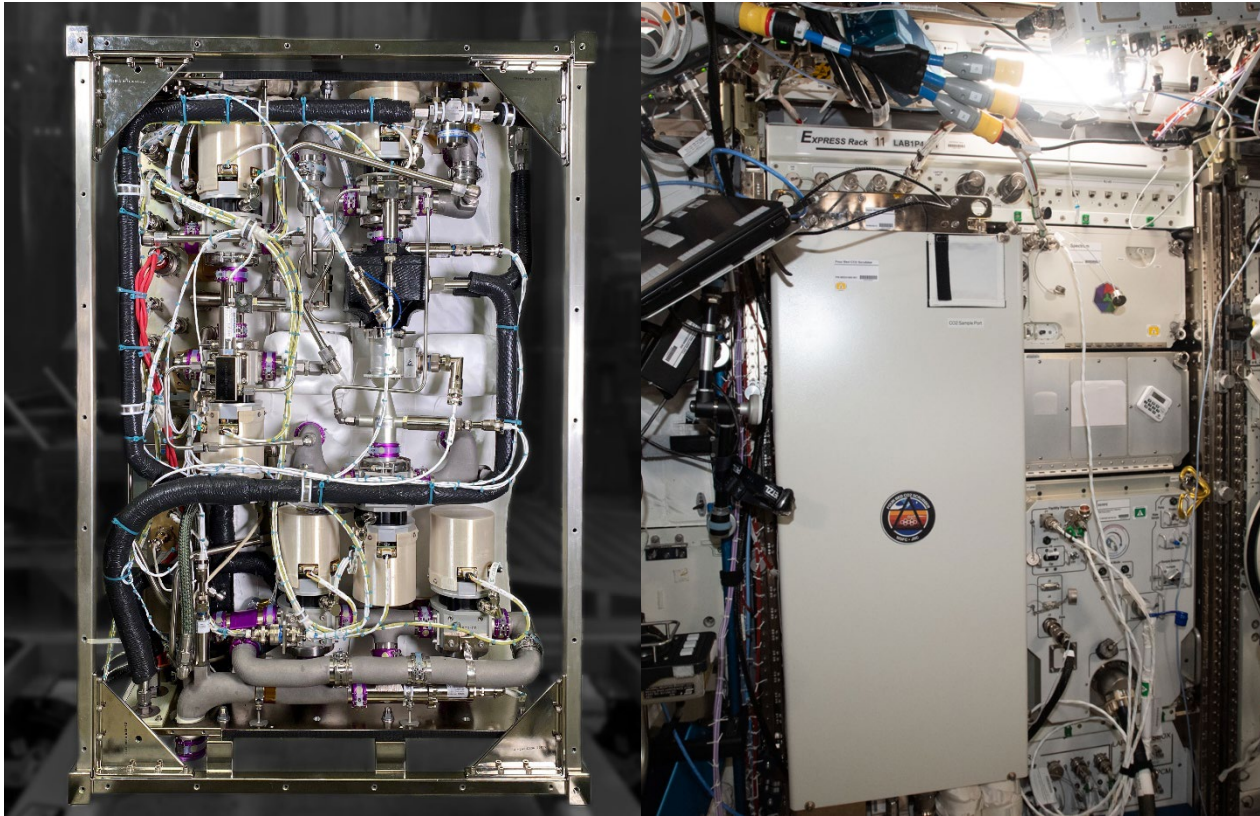
- Atmosphere Revitalization
 - Carbon Dioxide Removal
 - Trace Contaminant Control
 - Carbon Dioxide Reduction aka Oxygen Generation and Recovery
 - Oxygen Generation
 - High Pressure Oxygen
- Water Recovery and Management
 - Distillate/Condensate Processing to Potable Water
 - Wastewater Processing
 - Microbial Control and Dormancy
- Integrated Testing
- Architectures



CO₂ Removal

Four Bed Carbon Dioxide Removal

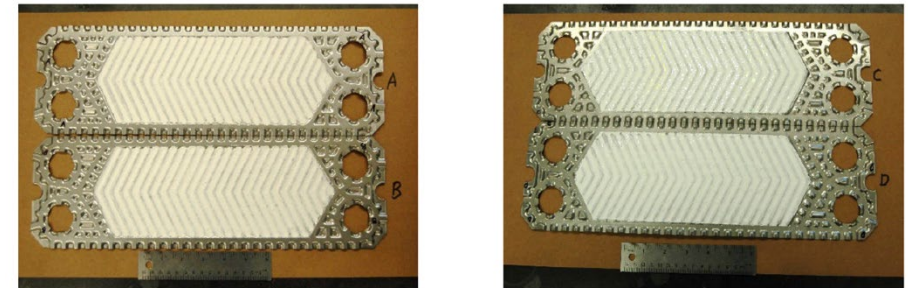
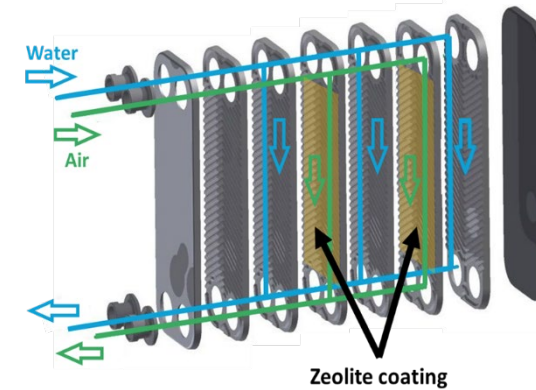
Uses a zeolite-based sorbent to remove CO₂



Four Bed CO₂ Removal System
During Ground Testing Installed on the ISS

CO₂ Removal by Rapid Cycle Temperature Swing Adsorption

Zeolite coated plates with active thermal control to improve CO₂ removal resulting in faster heat transfer and lower pressure drop resulting in smaller bed sizes.

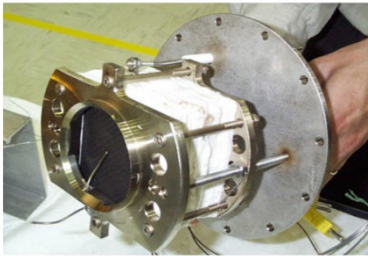


Beds Coated with Zeolite 13X

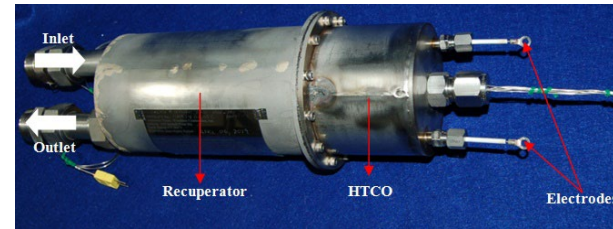
Trace Contaminant Control

High Temperature Catalytic Oxidizer Evolution

An exploration forward design consisting of a redesigned adsorption guard bed and a novel high-temperature catalytic oxidizer



α-Prototype (w/o heat recuperator)



β-2 Prototype (w. heat recuperator)



Catalytic Oxidizer Assembly Life Test Stand



Third Generation Catalytic Oxidizer

Photo Courtesy of Precision Combustion, Inc.

Oxygen Recovery

Increase Oxygen Recovery from ~ 50% to Greater than 75%

Increasing the amount of CO₂ processed by the Sabatier by recovering hydrogen from the Sabatier's methane byproduct

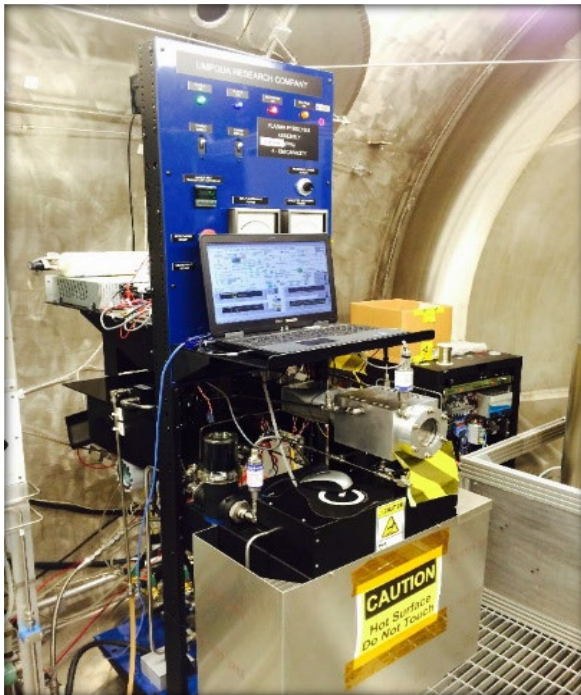
Methane Post Processor Assembly

Plasma Pyrolysis and H₂ Separation

Honeywell Carbon Vapor Deposition

Deposition of waste carbon within substrate.

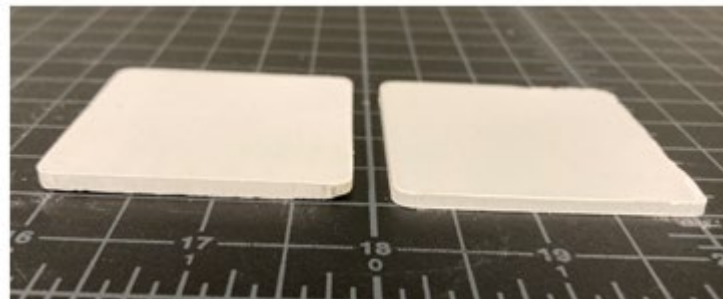
Produces a dense solid carbon product.



Plasma Pyrolysis Testbed



AYRSORB F25 and AYRSORB F100 MOFs
for Hydrogen Separation



Solid Oxide Electrochemical
Cell for Hydrogen Separation



Methane Pyrolysis Brassboard

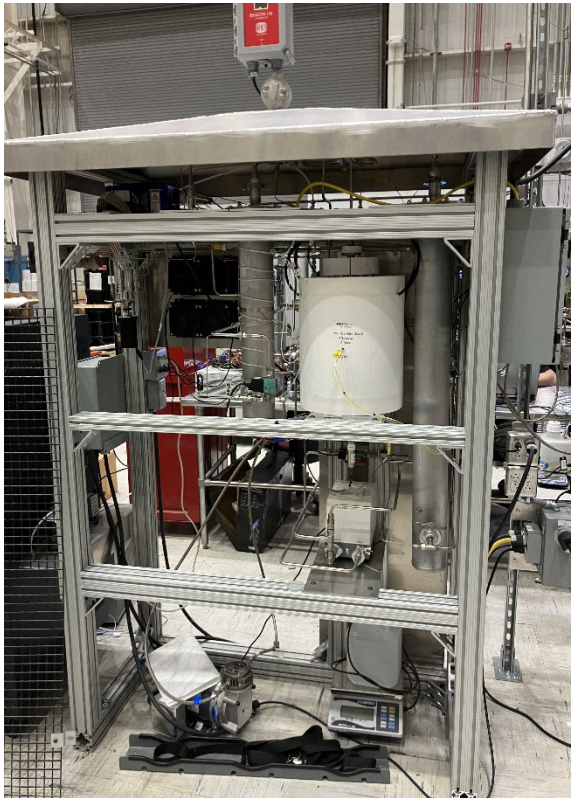
Photo Courtesy of Honeywell International, Inc.

Oxygen Recovery

Increase Oxygen Recovery from ~ 50% to Greater than 75%

Bosch Technologies

*Theoretical 100% oxygen recovery.
Replaces the Sabatier and Methane Processing*



Series Bosch Test Stand

CO₂ Reduction Utilizing Ionic Liquids

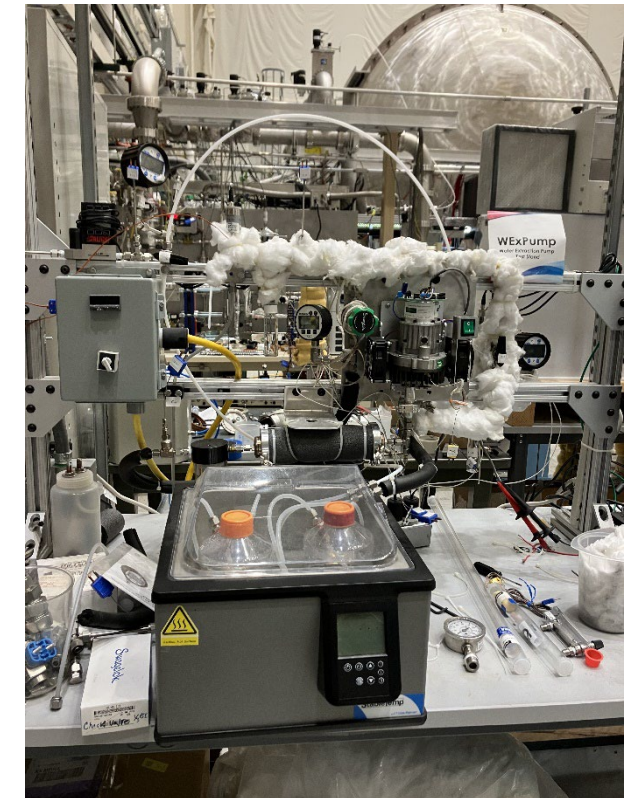
Use ionic liquids to clean copper catalyst used in Bosch technology



CORUIL Test Stand

Water Exchange Pump

The Water Extraction Pump (WExPump) will integrate the functions of a compressor, condenser, and separator into one single unit.



WExPump Test Stand

Oxygen Recovery

Increase Oxygen Recovery from ~ 50% to Greater than 75%

Macrofluidic Electrochemical Reactor

Reduces Carbon Dioxide to Oxygen and Ethylene

Replaces the oxygen generation, carbon dioxide reduction, and methane reduction functions



Electrolysis Test Stand



**MFECR installed into
the Electrolysis Test
Stand**

Oxygen Generation and High-Pressure Oxygen

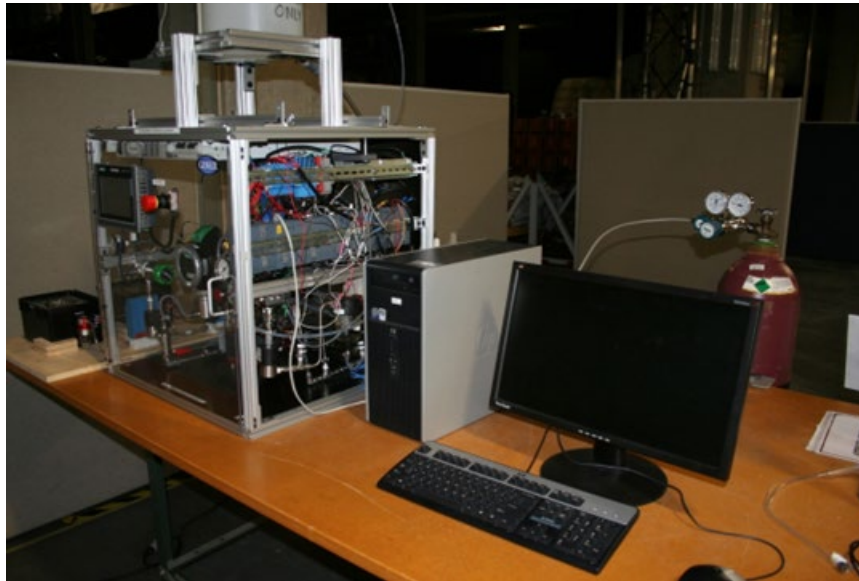


Static Vapor Feed Electrolysis

Electrolyzer technology to generate low pressure oxygen without a recirculation loop for water feed, no need for water-hydrogen phase separator



Giner SVFE Cell Stack



Giner Prototype System

Low Pressure Oxygen Compression

Cobham oxygen compressor for use in conjunction with the AOGA or SVFE to deliver high pressure oxygen

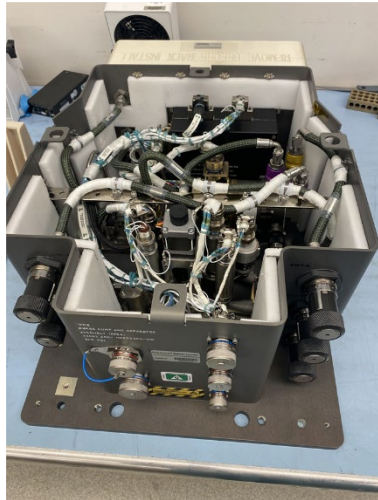


Cobham Oxygen Compressor

Urine and Brine Processing

Urine Processor Assembly

*Upgrades include a Pressure Pump
Separator Assembly, Distillation
Assembly Upgrades, and Single
Channel Pump*



**PPSA Prior to Flight to
the ISS**



Upgraded DA on the ISS

Planetary Urine Processor

*A simplified distillation technology to
process urine that takes advantage of the
gravity environment*



Concept 1a on PUP Test Stand

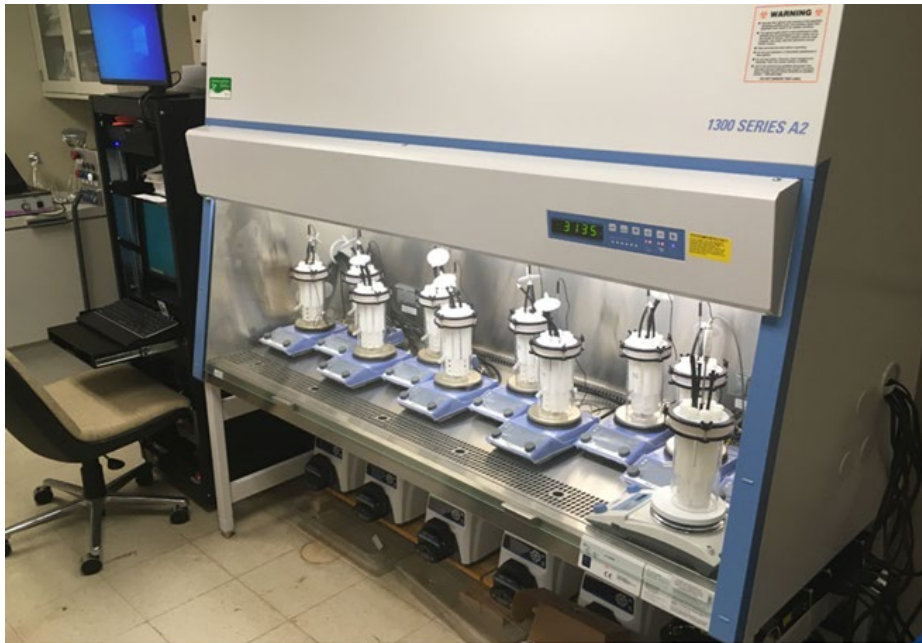
*ISS achieved 98% water recovery and has recycled
water equivalent to 20 Dragon resupply mission!!!*

Dormancy and Biofilms

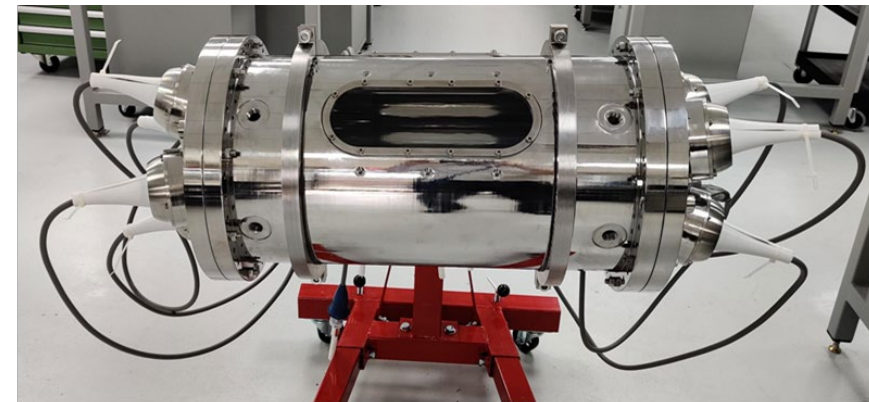
Dormancy could last for up to one year depending on the specific mission, but could be up to three years due to contingencies

NASA is investigating methods for:

- Preventing biofilm growth
- Controlling biofilm growth
- Removing biofilm growth



Biofilm Mitigation Surface Coatings Test Stand



Sanuwave Bellows Tank and Shockwave Applicators Test Set Up

Photo courtesy of Sanuwave

- Variable Atmosphere Test Facility
- Component and Integrated ECLSS Testing in Exploration Atmospheres



On Site Support Services

- Machine Shop
- Chemistry Lab
- MakerSpace: Hands on innovation space
- Rapid Prototyping Lab



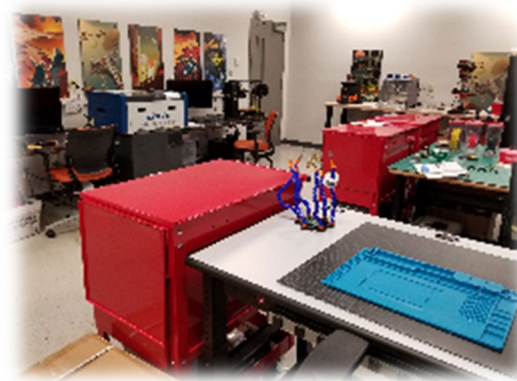
Machine Shop



Gas Analysis



Rapid Prototyping lab



MakerSpace



Wet-Chemistry Analysis Lab

What can we do?

- Partnerships!
- Full life cycle of regenerative ECLSS at any level of engagement from consultation to flight hardware delivery
 - Design
 - Develop
 - Test and Evaluation
 - Implementation

