Assembly and Integration Status of a High Fidelity Ground Test Bed for the Water Processor Assembly

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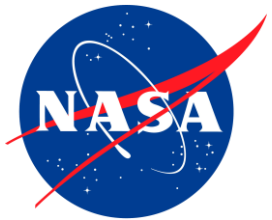
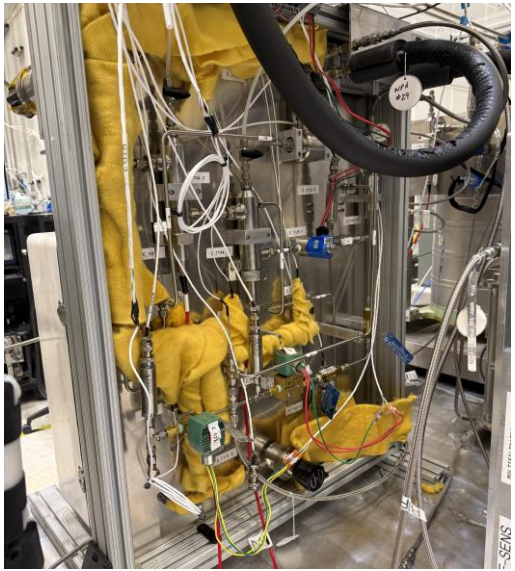


Agenda

- Project overview
- History of WPA ground testing
- Flight hardware vs COTS hardware
- Challenges
- Future objectives

Background

- The Water Processor Assembly (WPA) serves as the final leg of the Water Recovery System on the ISS
- The ECLSS team at MSFC has been tasked with building a high-fidelity test stand to develop technologies for missions beyond low Earth orbit
  - Test bed integrates flight spares with commercial off the shelf (COTS) components to operate within same design parameters as flight assembly
  - Resultant data will allow for better understanding of how system responds to varying conditions and provides a mechanism for developing necessary system modifications



Ground Test Catalytic Reactor

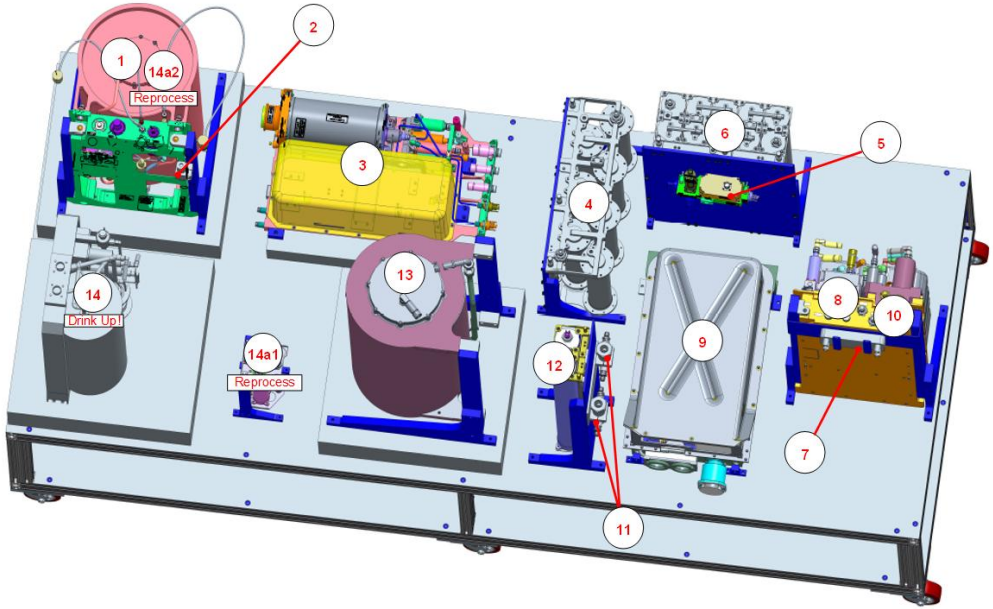
At a Glance

Process Water Flow Path:

1. Waste Water ORU
2. External Filter Assembly
3. Pump/Separator ORU
4. Particulate Filter ORU
5. Sensor ORU
6. Multifiltration Bed ORU
7. Precooler Heat Exchanger
8. Catalytic Reactor ORU
9. Gas Separator ORU
10. Catalytic Reactor ORU (again)
11. Reactor Health Sensor ORU
12. Ion Exchange Bed ORU
13. Water Storage ORU
14. Water Delivery ORU

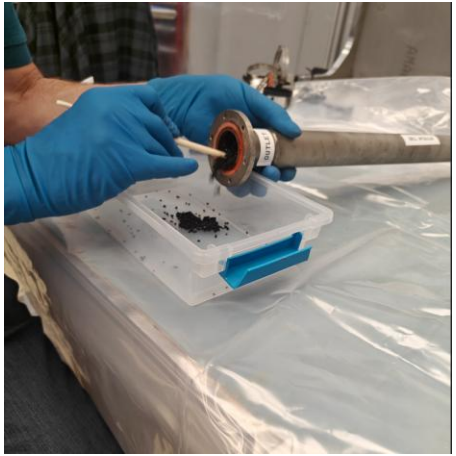
14a1 Microbial Check Valve ORU (if re-processed)

14a2 Waste Water ORU (if re-processed)



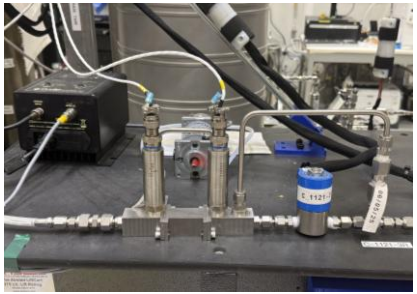
Objectives

- Develop high fidelity system for current on-station activities and future missions beyond the Moon
  - Improve reliability data
  - Alleviate strains of obsolescence, including testing novel formulations
  - Research new components for system compatibility and flight-like functionality



Legacy catalyst removed from development Catalytic Reactor

Ambersorb 4652 (Dupont), no longer manufactured by vender



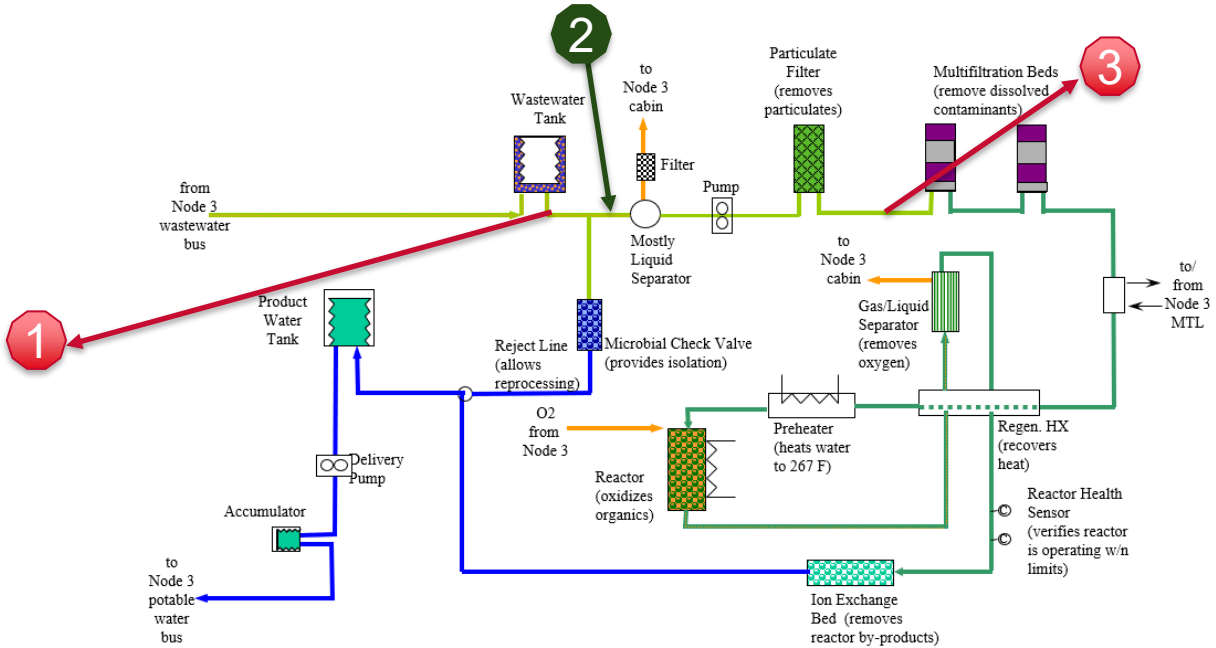
COTS (Fluid Metering) pump being used as WP3 Process Pump

Immediate Goals

- Success criteria for WPA is determined by its ability to generate potable drinking water from a source of non-potable water
  - On station, this is a combination of UPA distillate and humidity condensate
- Ground test bed will initially be fed using Ersatz fluid mixed in-house
  - Future endeavors will integrate entire water string with:
    - Inlet fed from UPA ground unit
    - Outlet fed to OGA ground unit

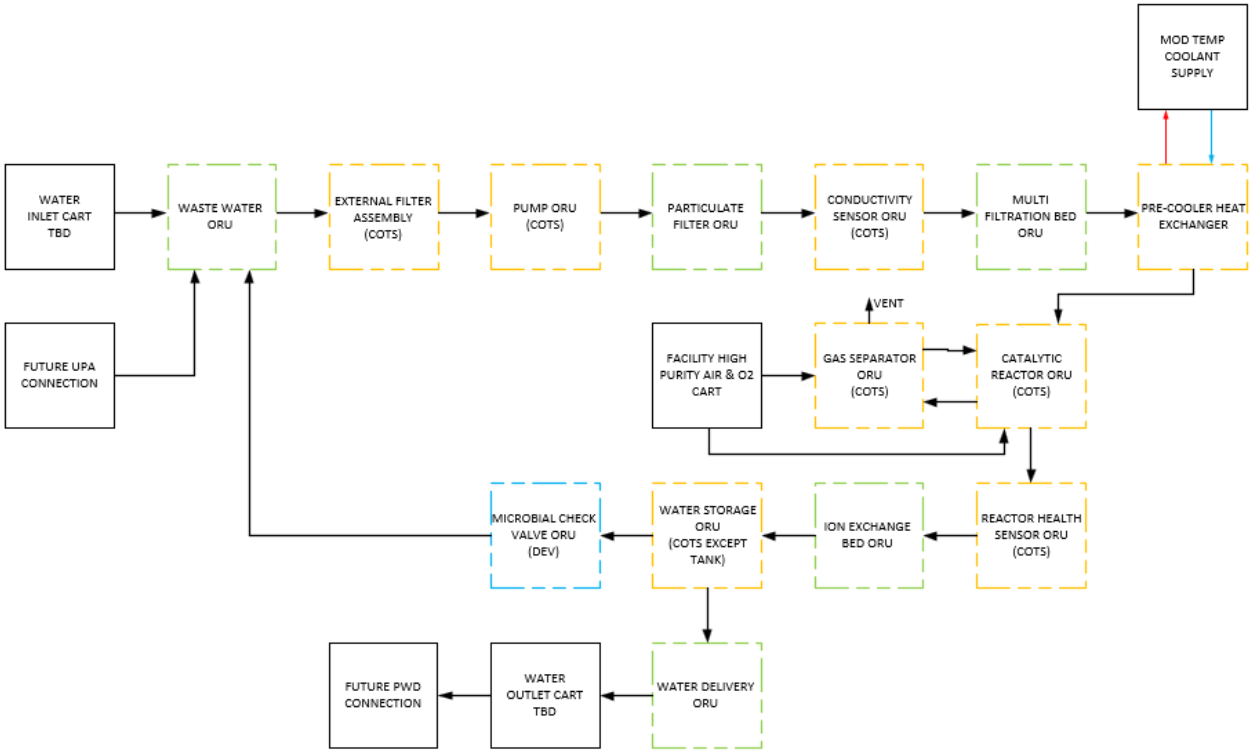
History

1. Removed solenoid from outlet of Wastewater ORU
2. Added External Filter Assembly between Wastewater ORU and Mostly Liquid Separator/ Pump Separator ORU
3. Downsized to single Multifiltration Bed
4. New MF Bed media and CHIPS air filters to mitigate DMSD



WPA 2009

Flight vs COTS

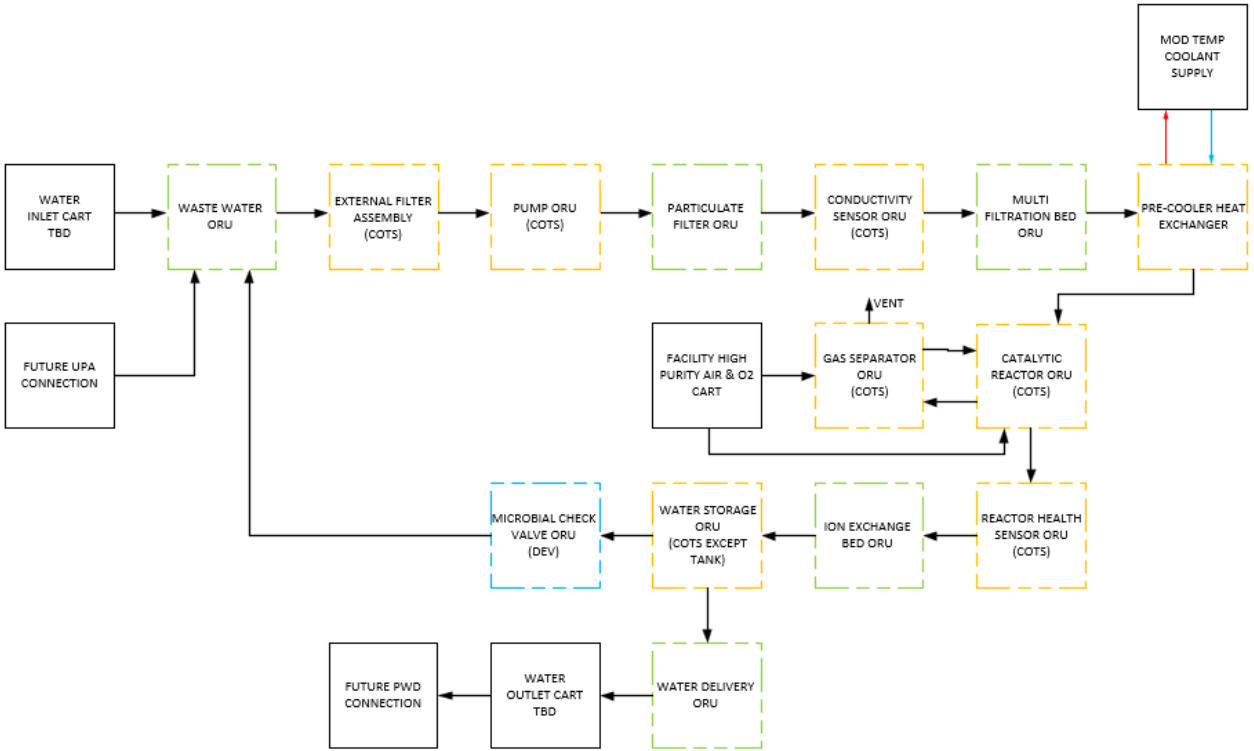


Orbital Replacement Unit (ORU)

Commercial-off-the-shelf (COTS) Unit

Development Unit

Flight vs COTS



Flight

- Wastewater ORU
- Particulate Filter ORU
- Multifiltration Bed ORU
- Ion Exchange Bed
- Water Storage Tank (only
- Water Delivery ORU

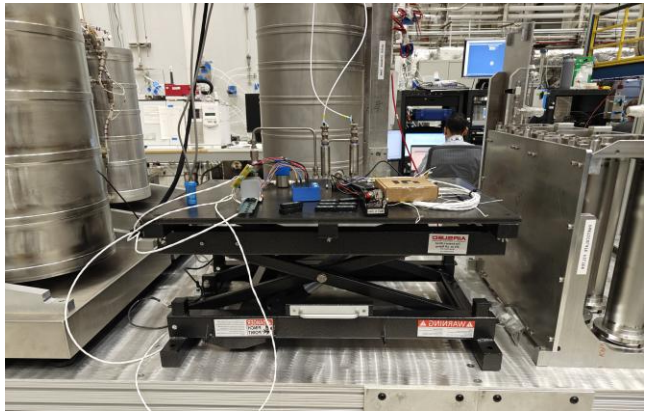
Non-Flight

- Pump Separator
- External Filter Assembly
- Sensor ORU
- Pre-cooler Heat Exchanger
- Catalytic Reactor
- Gas Separator
- Reactor Health Sensor
- Water Storage Sensors and Valves
- Microbial Check valve
- Process Controller

COTS Explained

Component Type	Flight Manufacturer	COTS Manufacturer
Pressure	Tavis	GP50
Conductivity	Rosemount	ABB
Solenoid Valves	ValveTech	Valcor, Asco
Filters	Norman	Norman
Relief Valves	ValveTech	Circle Seal
Pump/ Motor	Cascon/ Kearfott	Fluid Metering Inc.
Conductivity	Rosemount	ABB
Lift Table	N/A	Airsled
Back Pressure Regulator	Carleton	Tescom
QDs/ fittings	Boeing	Swagelok
Check Valves	ValveTech	Kepner
RTD (T-couple)	RDF Corp.	Cole Parmer
Heat Exchanger	Collins	Bell and Gossett
Catalytic Reactor	Collins	In-house
MCV	Collins	Development
Cables	Collins	In-house
Controller	Collins	DAQ, LabVIEW

COTS Buildup



Process pump and automated lift table

Conductivity probe and pressure sensor

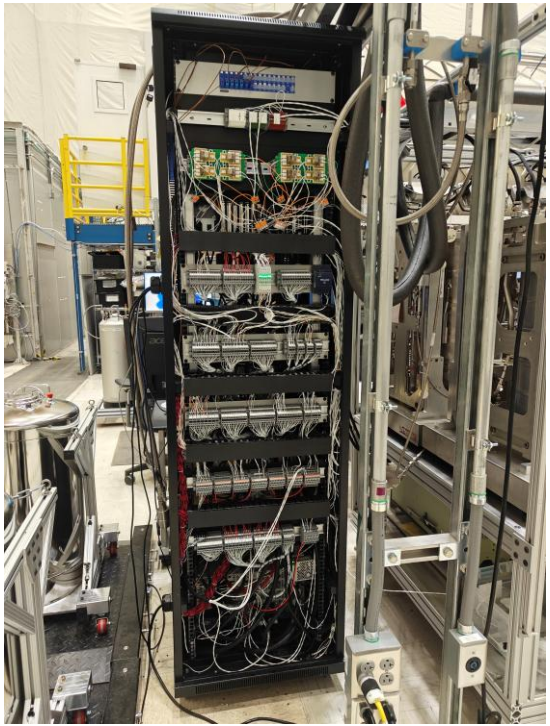
Conductivity transmitters

Development catalytic reactor manifold

Final Build

Non-potable side

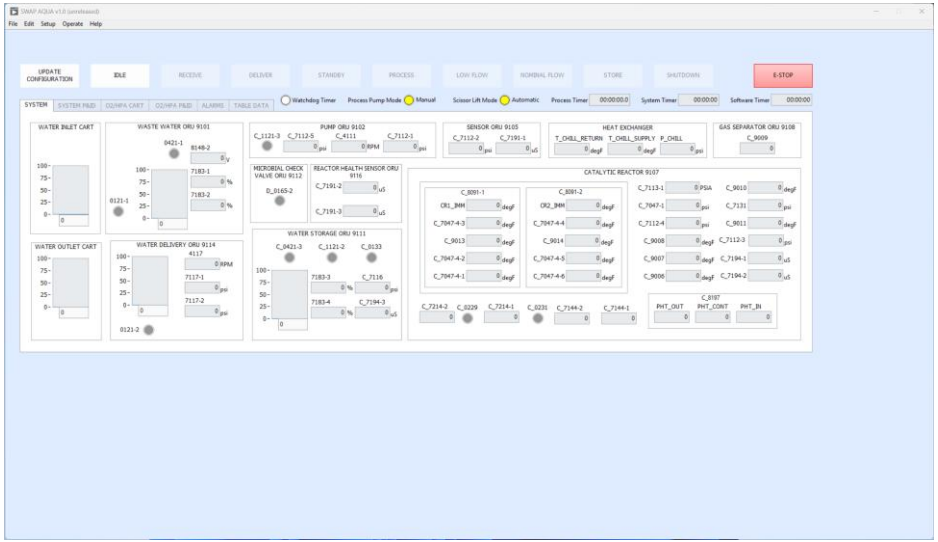
Potable side



cDAQ wiring

Software Integration

- WPA Ground Test Bed will be operated through a custom LabVIEW based architecture.
- Goal for test bed software to allow for full test bed operations with minimal supervision.



Initial Mock-Up of WPA Test Software
(developed by Stephen Thompson and Derek Mayer, ASED MSFC)

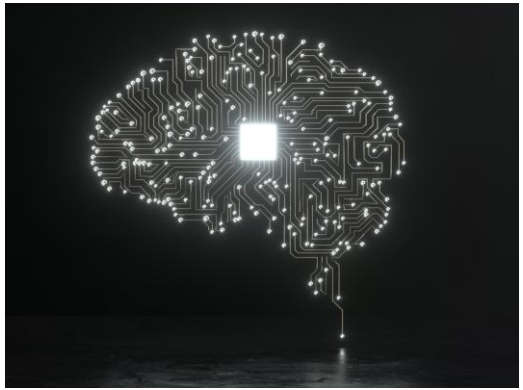
Challenges

Mimicking microgravity:

- Necessary for understanding fluid flow and preventing channeling in media-containing beds subassemblies

Controller logic:

- Using LabVIEW software program to control test bed, instead of Process Controller ORU
- Requires innate understanding of on-station commands and fitters



Balancing priorities:

- Need to understand gaps of understanding to determine testing precedence
- Differentiate between standalone operation or integrated operation, as well as critical runtimes of subassemblies

Future Objectives

- Explore challenges presented by long-duration missions
  - Dormancy
  - Earth-independent operations
  - Accessibility for repairs
- Gather further operation for statistic reliability
  - Component runtime
  - Contaminant removal
  - Data to be used by predictive models
- Establish flight-like functionality such that current obstacles can be better understood
  - Testing new media/ filtration types
  - Mitigating undesirable constituents (e.g. DMSD)
  - Understanding and innovating new technologies to replace existing components
  - Adjusting operating parameters in favor of hardware preservation

Questions?

Thank you for your time!