ICES404: ICS – International Space Station ECLS: Systems
07/17/2023

Status of ISS Water Management and Recovery

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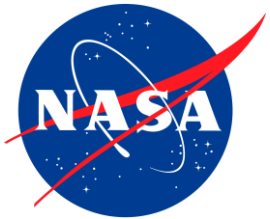
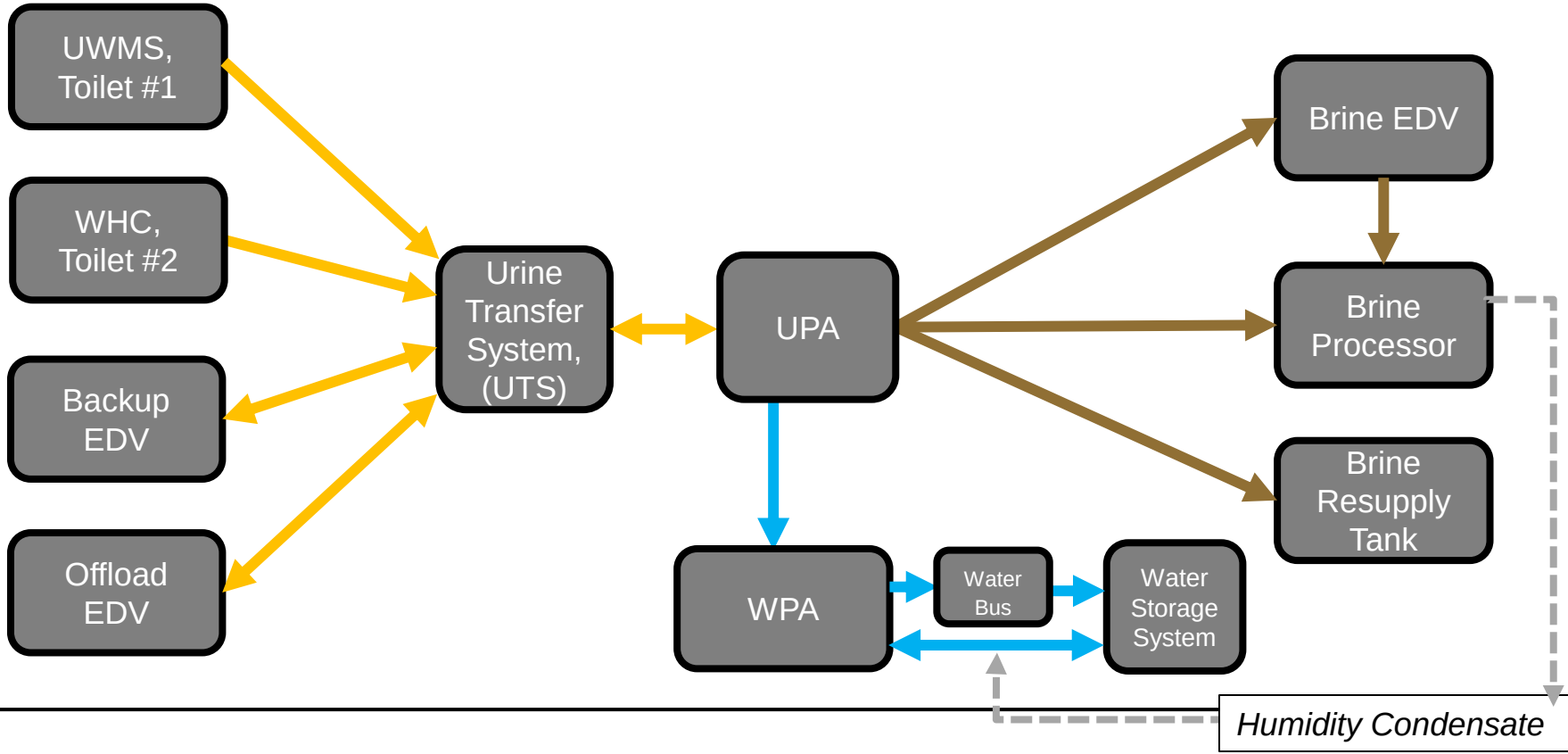


Agenda

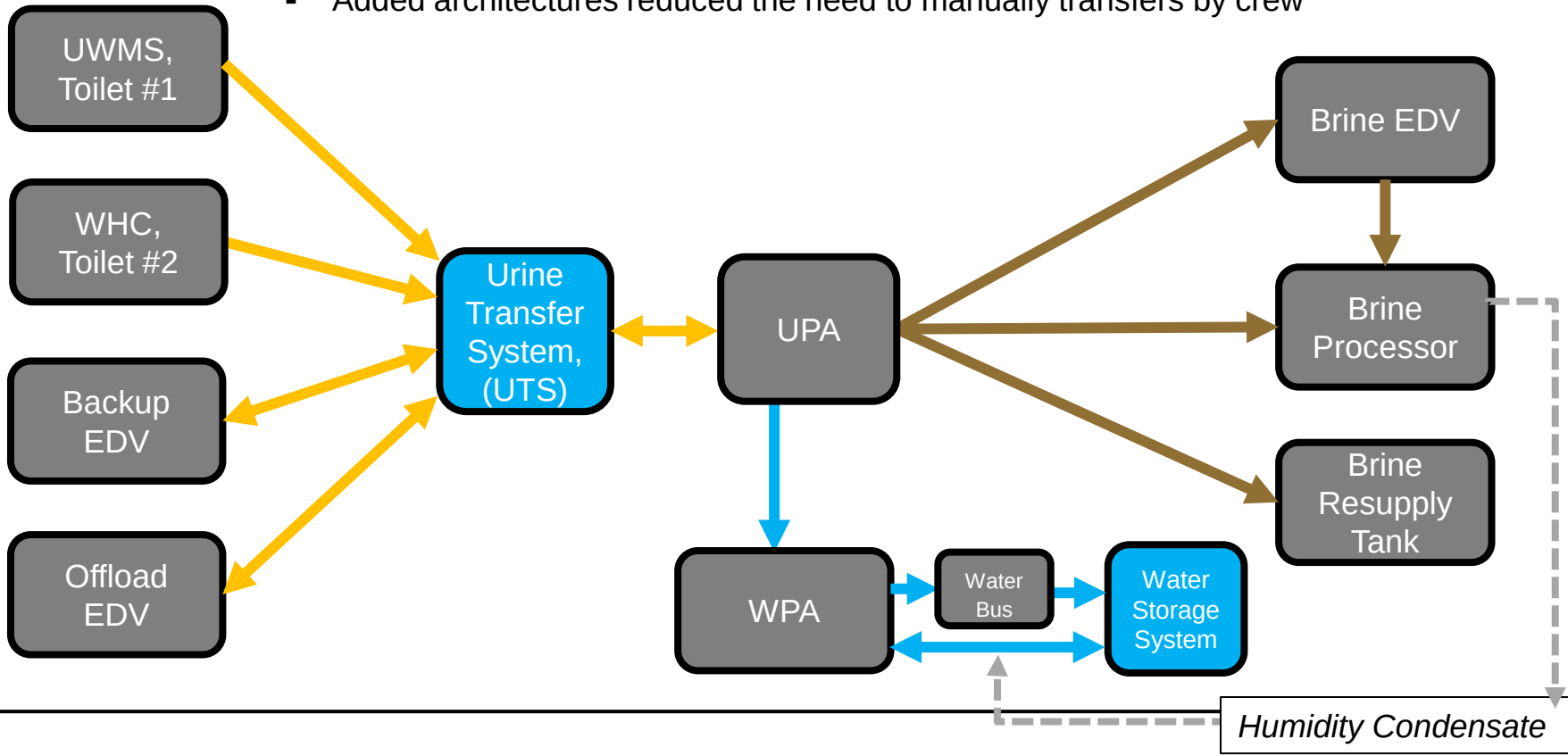
- Water Recovery System Architecture
- Urine Processor Assembly and Status
- Water Processor Assembly and Status
- Big Picture Status for other ISS Tech Demos

System Architecture, Water/Wastewater Management



System Architecture, Water/Wastewater Management

- Added architectures reduced the need to manually transfers by crew



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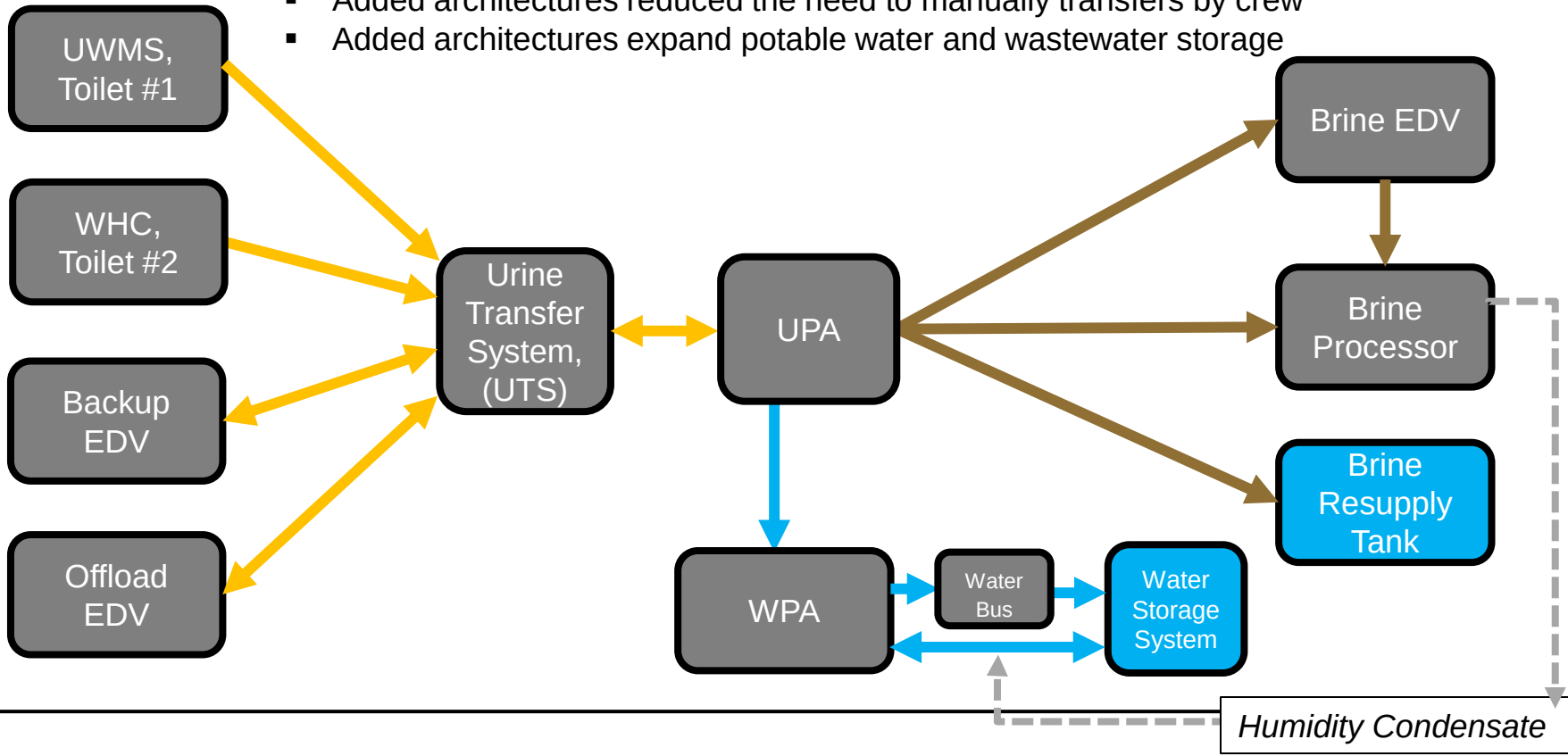
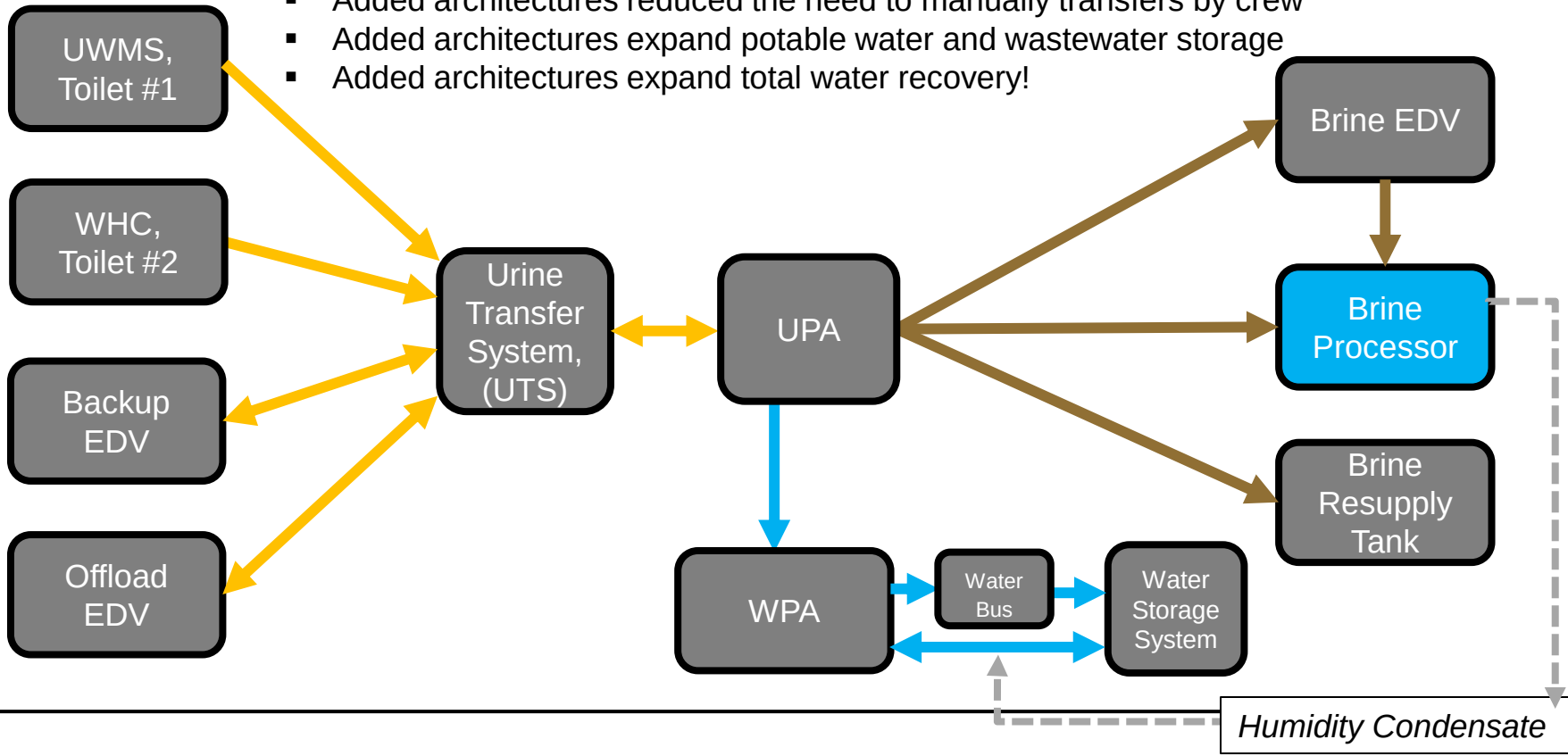
- Added architectures expand potable water and wastewater storage

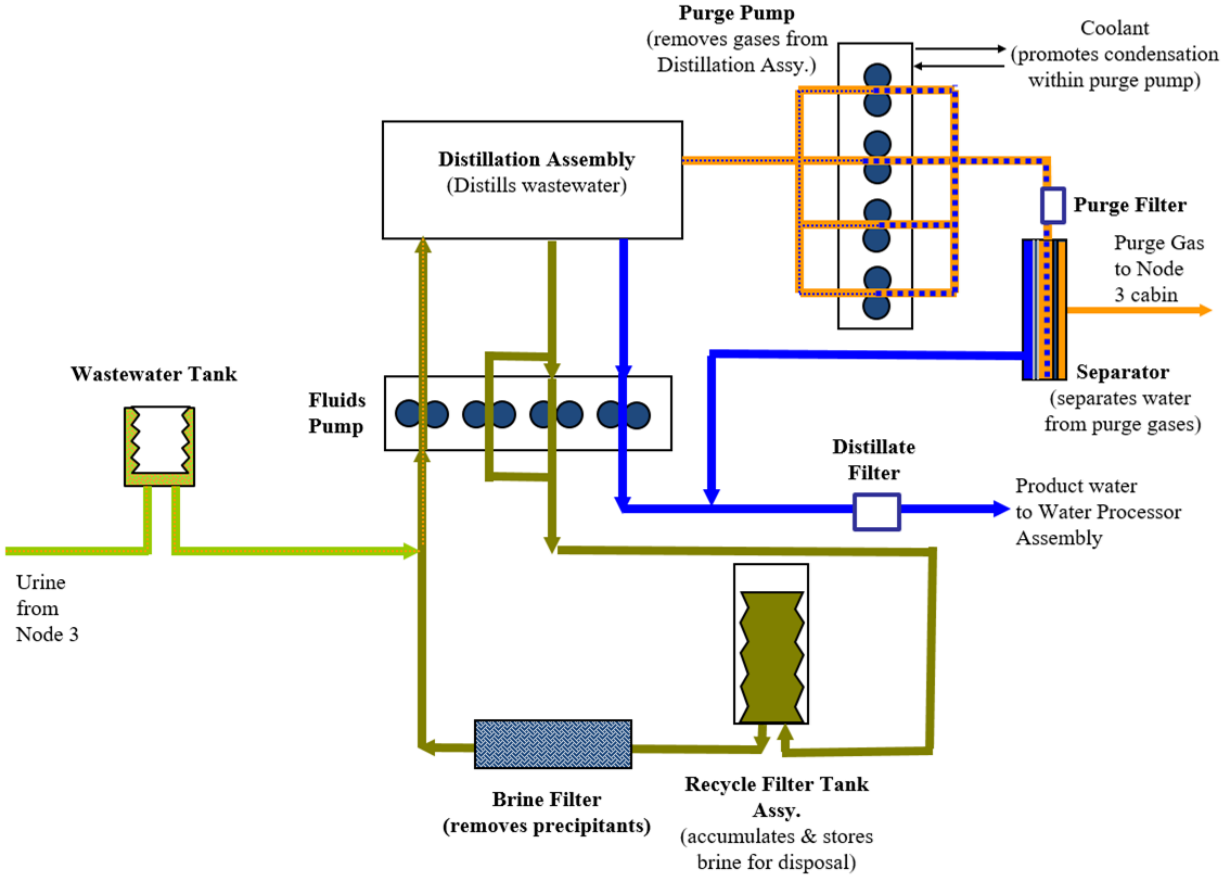


System Architecture, Water/Wastewater Management

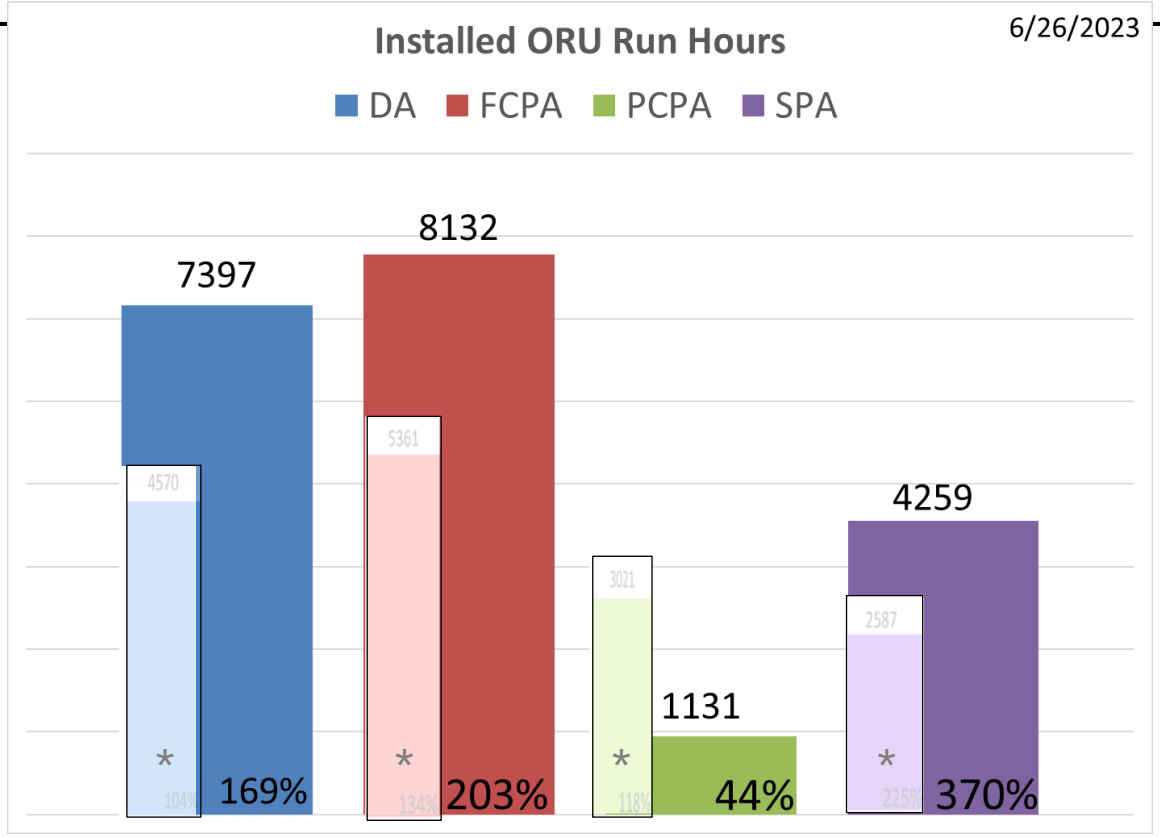
- Added architectures reduced the need to manually transfers by crew
- Added architectures expand potable water and wastewater storage
- Added architectures expand total water recovery!



Urine Processor Assembly Simplified Schematic

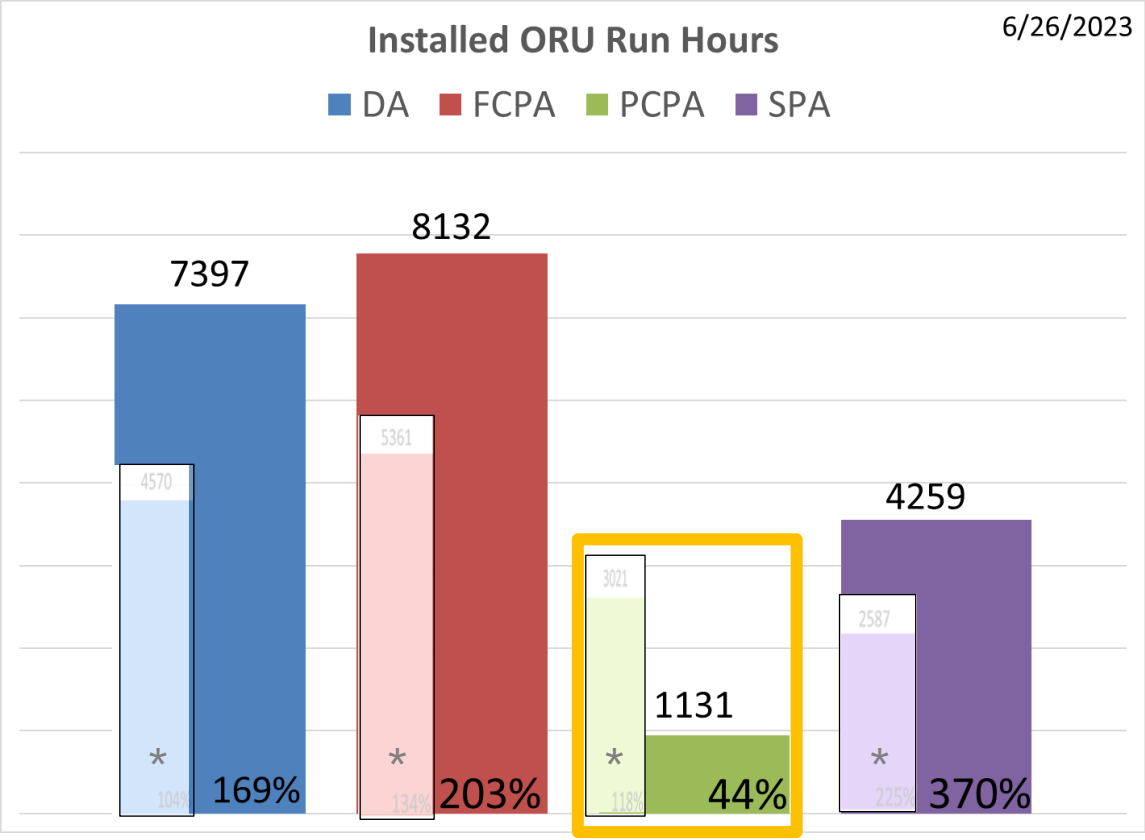


Runtime Hours to Predicted Hours



* Comparison to 2022 data

UPA Purge Pump Failure



Since 2022, UPA experience a PCPA peristaltic tube rupture.

Known failure mode.

Last recurrence was *Oct 2016*

* Comparison to 2022 data

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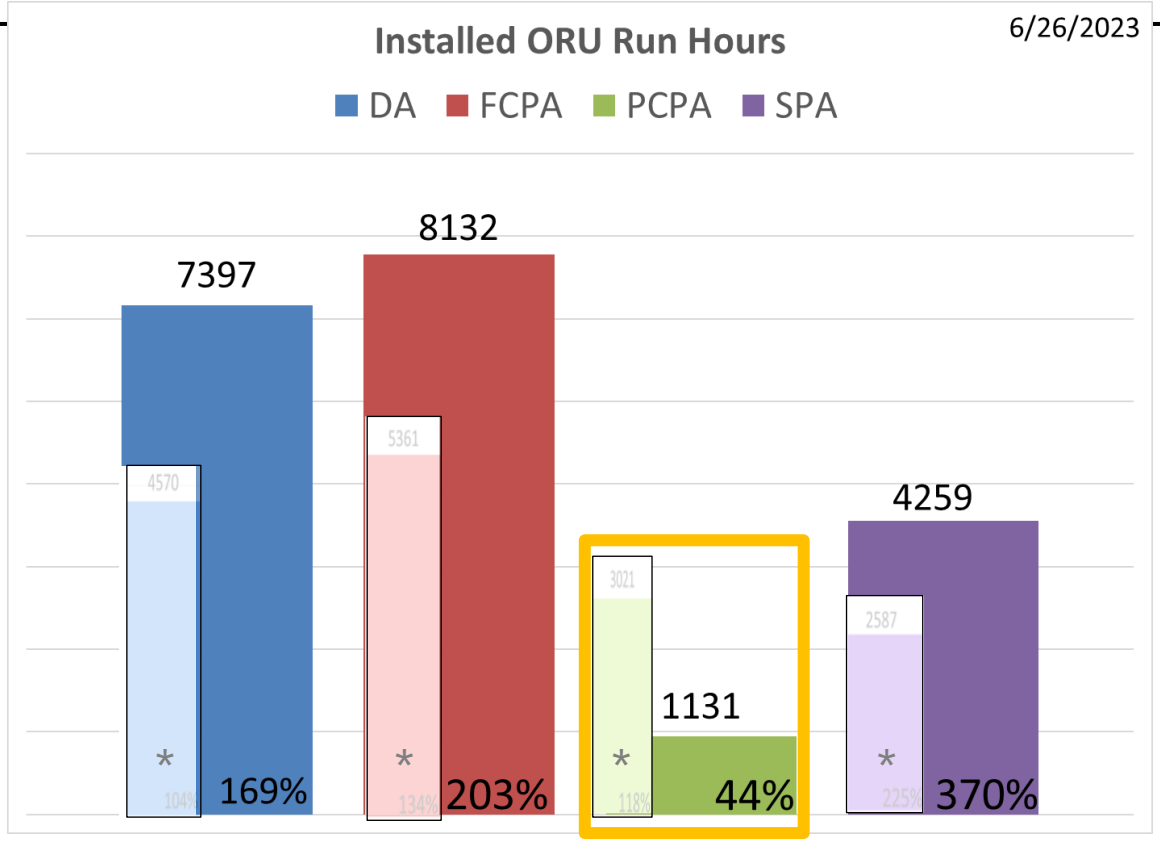

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UPA Tech Demo:
Purge Pump and Separator Assembly (PPSA)

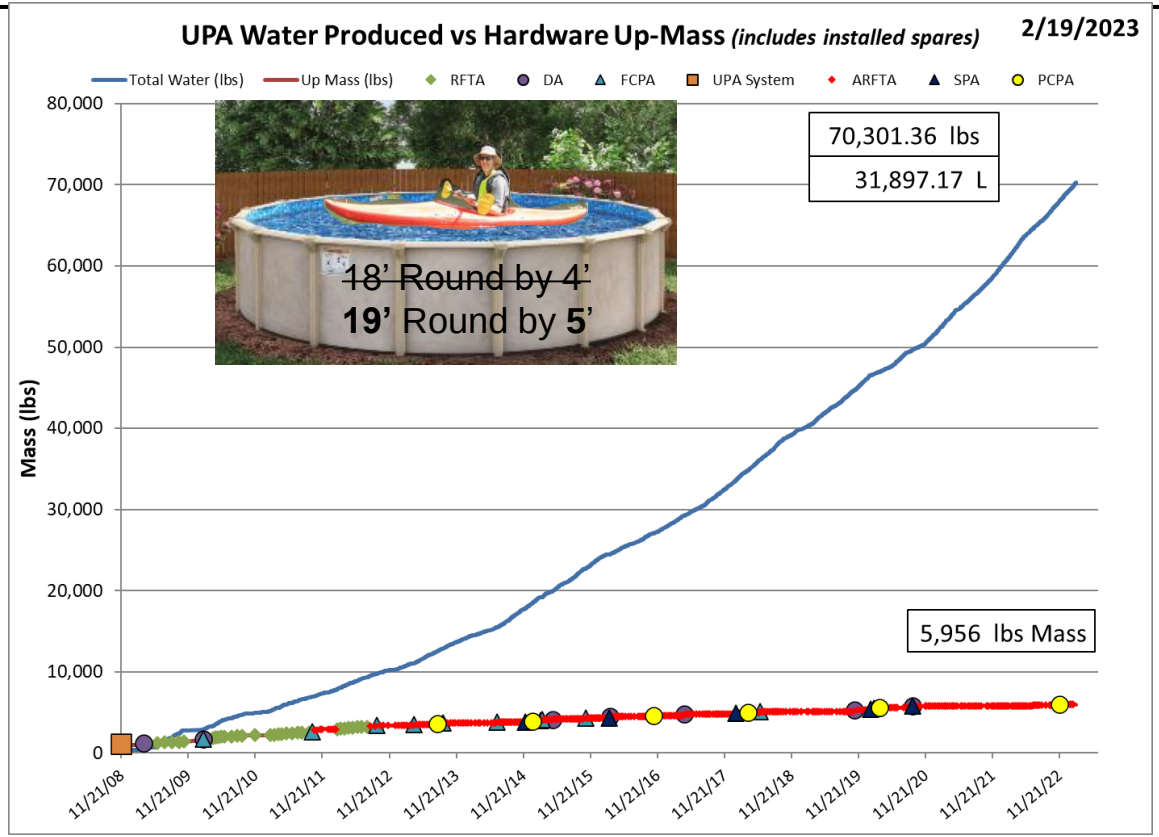
Arrival of new purge pump (***scroll pump design***) at the end of 2022

Expected installation early July 2023!

* Comparison to 2022 data

UPA Water Produced vs Hardware Up-mass

- PCPA
- FCPA
- SPA
- DA



UPA Metrics and Waste Management

Table 1. UPA Metrics Comparing Last Three Years of Operations

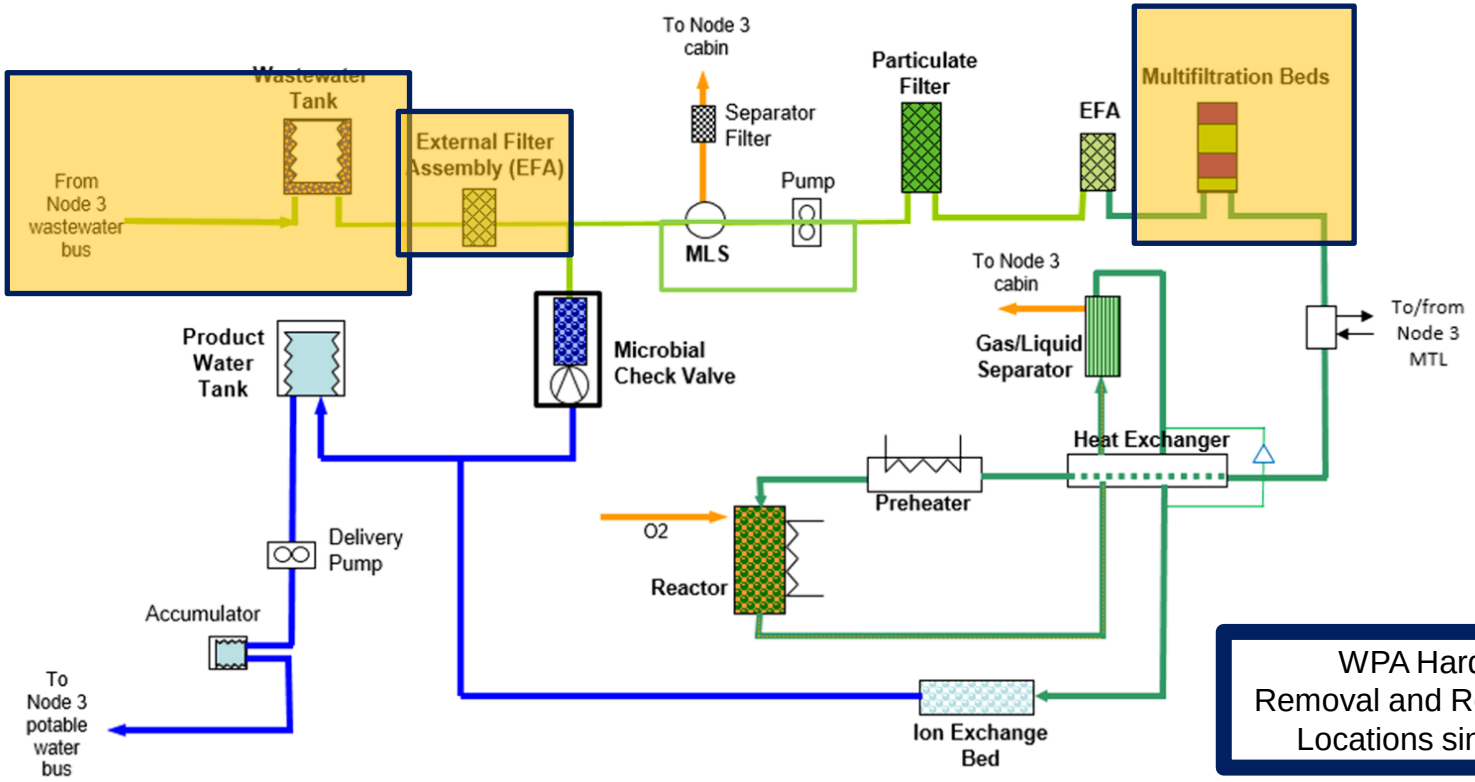
Year	Ave ISS Crew Size	Process Runs	Concentration Cycles	Processing Hours	Total Urine Pounds Processed (lbs)	Total Pounds Brine Generated (lbs)
2020	5 (max: 6)	245	25	1657	5355	1197
2021	8 (max: 11)	326	34	2544	8296	1627
2022	8 (max: 11)	345	44	2786	9278	2105

To the credit of upgraded hardware successfully incorporated into UPA, most significantly within the DA, UPA has maintained a high level of performance during the increase of crew size and continued processing of Russian urine.

UPA has seen significantly more operational run time (>30% increase) in a given year since 2020 and generated >30% more brine volume/mass.

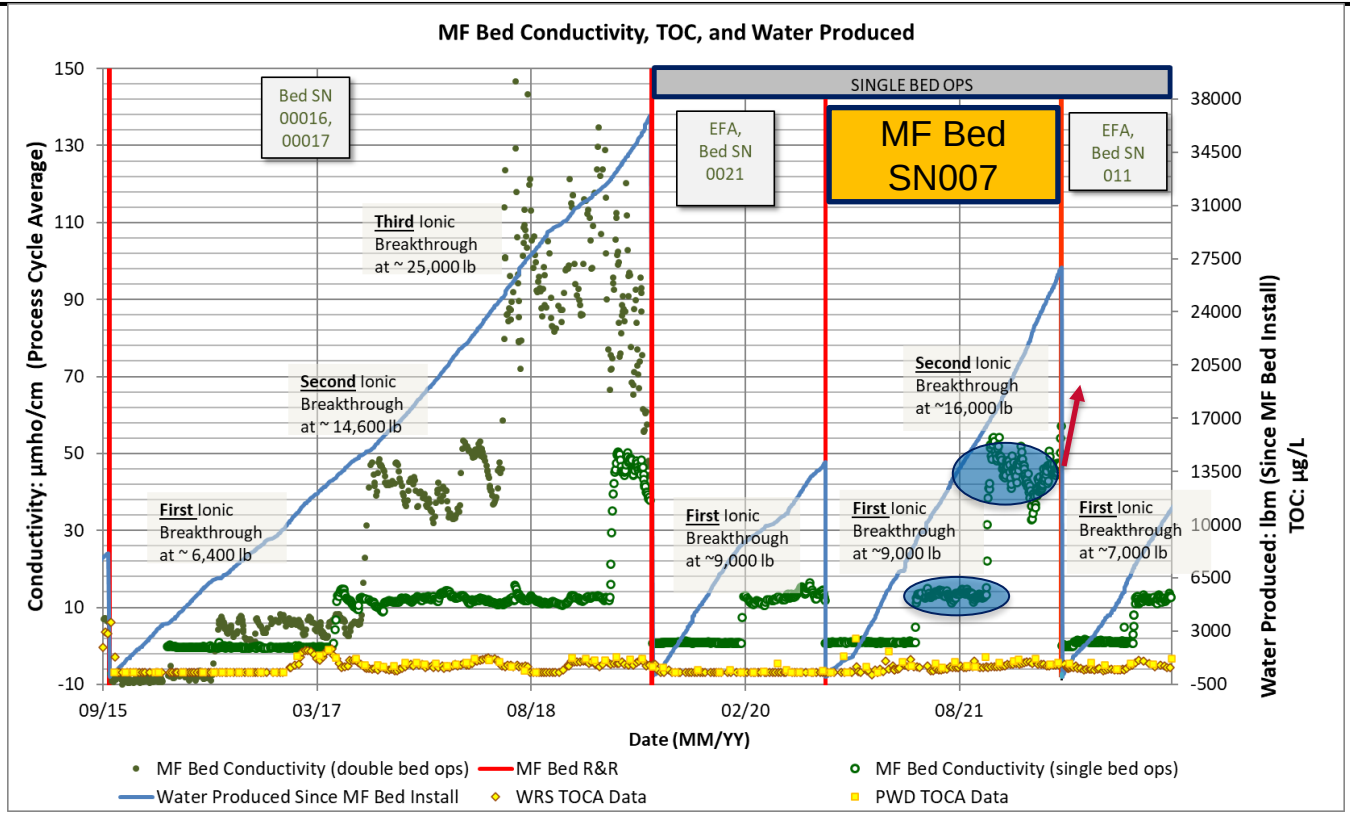
…the Brine Processor has provided a significant reduction in trash management and logistics by reducing the total volume of brine for disposal (trashing off the ISS vehicle)

Water Processor Assembly Simplified Schematic



WPA Hardware Removal and Replacement Locations since 2022

Multi-filtration Bed Trending



Since 2022, WPA's MF Bed SN007 (Upgraded) experienced the expected third ionic breakthrough requiring replacement

Was able to process over 26,800 lbs of wastewater.

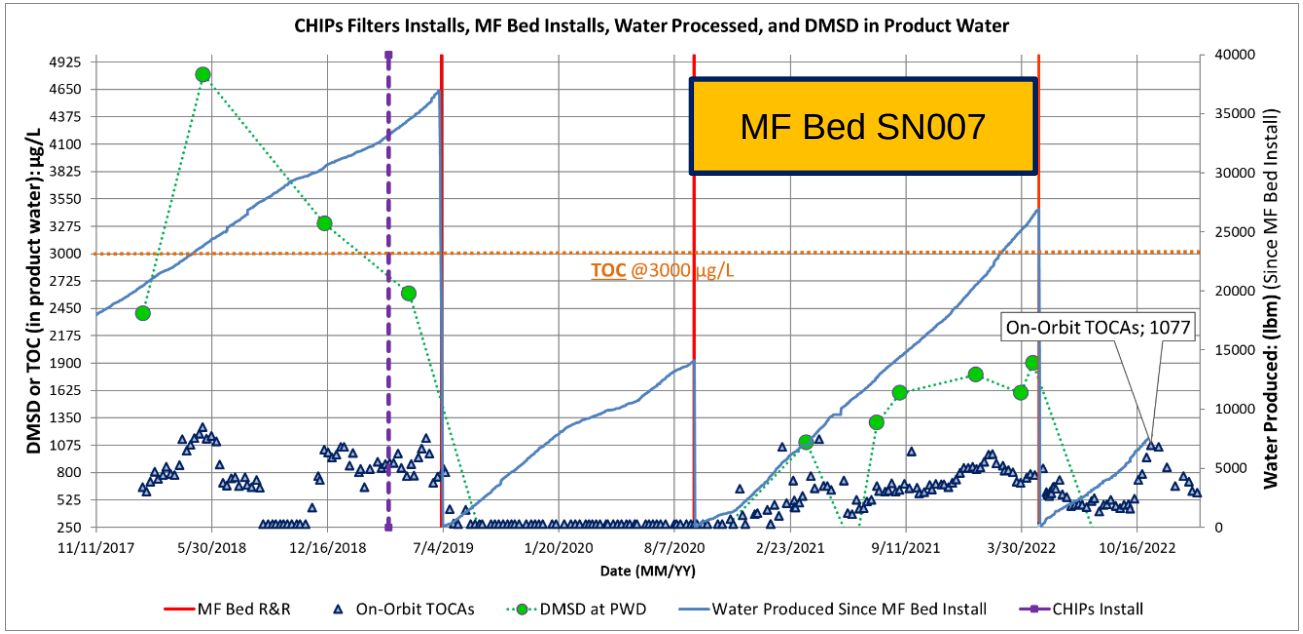
SN011 (Upgraded) was installed

Processed 8,700 lbs of water before it reached its first expected ionic breakthrough

All within family

TOC/DMSD responses in product water

Dimethylsilanediol (DMSD)



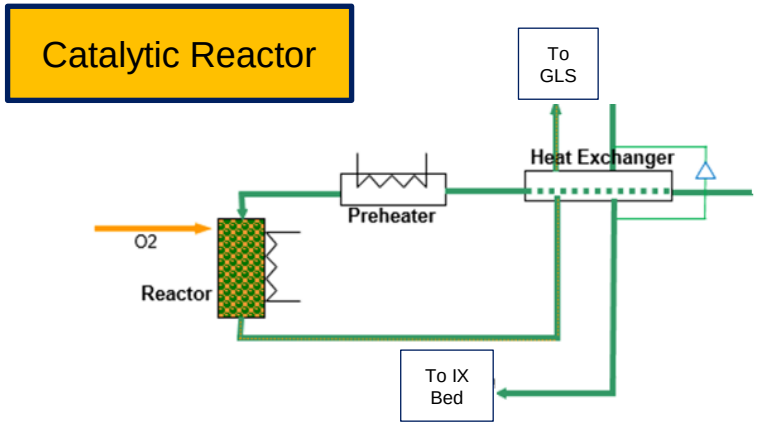
Over the course of MF Bed SN007 install, TOC and DMSD increases were reported.

Due in part to nominal MF bed breakthrough but the resurgence of pre-cursors to DMSD generation in cabin atmosphere.

Thankfully, these TOC and DMSD 'waves' were significantly more manageable and did not challenge potable water quality.

Testament to Single Bed Ops success, in tandem, to upgraded Ambersorb sorbent performance ….and early success of advance cabin air filters

Catalytic Reactor, Legacy Design

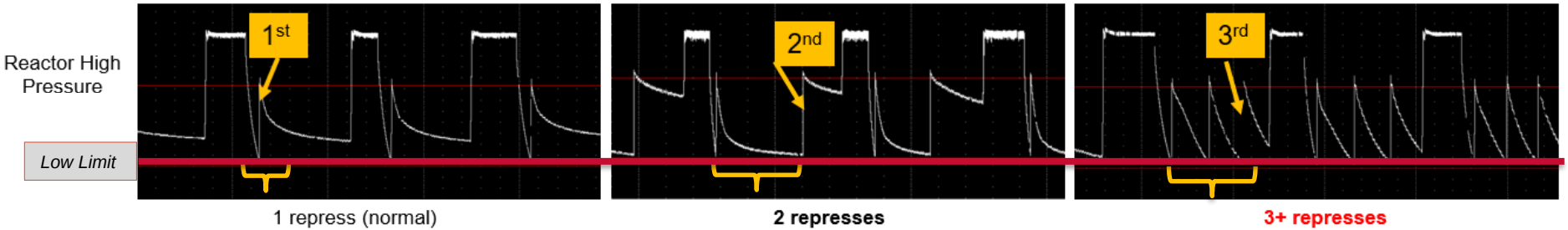


Since 2022, the legacy Catalytic Reactor SN005 began seeing indications of external water leakages

Well understood failure mode, due to elastomeric seals degradations in this high oxygen and temperature cycling operation

However, the unexpected nature of this failure mode was the time-to-effect. The leak started ~ 1 year or ~ 150 process cycle operationally compared to ~2 or 300 – 400 process cycle

May suggest new operation impact or in tandem with a secondary failure, TBD, internal to the cat reactor (isolator valve/pressure reg)



Upgraded Demo Cat. Reactor

- The Demo Catalytic Reactor underdone rework to correct the seal glands to proper size to accommodate the selected metal seals.
  - *The concluded failure mode for premature failure on-orbit*

- A new testing procedure has also been developed and is being implemented to incorporate improved flight-like heat cycling and increased leak testing during and post-processing to ensure a leak-tight ORU and avoid recurrence of infancy failure.

- Demo Catalytic Reactor is now on orbit awaiting install after current unit fails

Tech Demos, where are we now!

UWMS, Toilet #1

Tune in for **ICES 2023-038** for detailed information

Since February 2022, Toilet has seen several more restart attempts and limited check-outs to further realize technology demonstrations and Artemis perspective test objectives.

The lack of direct monitoring pretreat dose quality and reported fluid release internal to the Toilet operations have been notable, thus, limiting crew use. At this time, Toilet is in a stand-down configuration until hardware replacement can be supplied.

Brine Processor

Tune in for **ICES 2023-292** for detailed information

Since February 2022, BPA has completed 14 dewatering cycles, approximately 305 liters of urine brine.

Of that, it is estimated ~260 liters of water has been returned back to humidity condensate, a significant water return!

[TOTAL WATER RECOVERY PERSPECTIVE]

Combining UPA with BPA and WPA Water Recovery Rates, we have demonstrated an effective Total Water Recovery of 98-99%!

Conclusions

- Critical paths of challenging the next generation ELCSS technologies in the relevant space environment continue to be realized in a relevant environment
- UPA continues reach unprecedented milestone of operational hours thanks to the many years of upgrades and redesigns
  - PPSA Tech Demo will go live here real soon, if not already!
- The new MF Bed operations and configurations have allowed for longer operational install time thanks to the reduction and continued positive trending of overall DMSD concentrations in the water
  - WPA can now operated an MF bed through its intended design of ionic breakthrough!
- Continue to see expected failure modes of the legacy cat reactor design
  - Thus, it is critical to get DTO back online to test the final leg of the DMSD mitigation efforts
- Exception performance metrics from Brine Processor, demonstrating ability to further resolve the total water recovery rates!

Questions?

Thank you for your time!