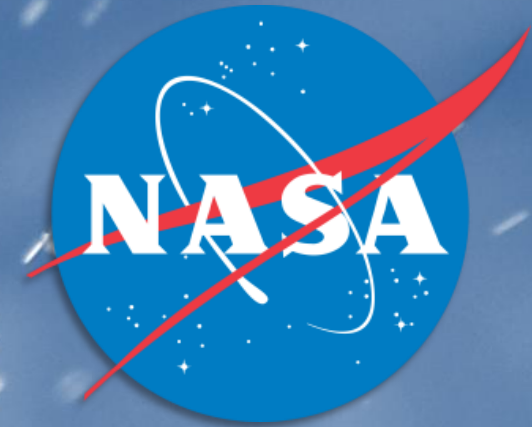


Water: A Critical Material Enabling Space Exploration



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Houston, TX, 77058



Presentation Outline



- **Where is NASA going?**
- **Why is water critical to NASA's mission?**
- **Recovering water from wastewater**
- **Water quality for humans and hardware**
- **Technology needs for exploration**

Acronym Primer



- **ISS = International Space Station**
- **WRS = Water recovery system**
- **EVA = Extravehicular activity**

So what is NASA really doing?



HUMAN EXPLORATION
NASA's Path to Mars

EARTH RELIANT
MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS

Learning fundamentals aboard the International Space Station

U.S. companies provide access to low-Earth orbit

PROVING GROUND
MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS

Expanding capabilities by visiting an asteroid in a lunar distant retrograde orbit

Traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft

MARS READY
MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS

Exploring Mars, its moons and other deep space destinations



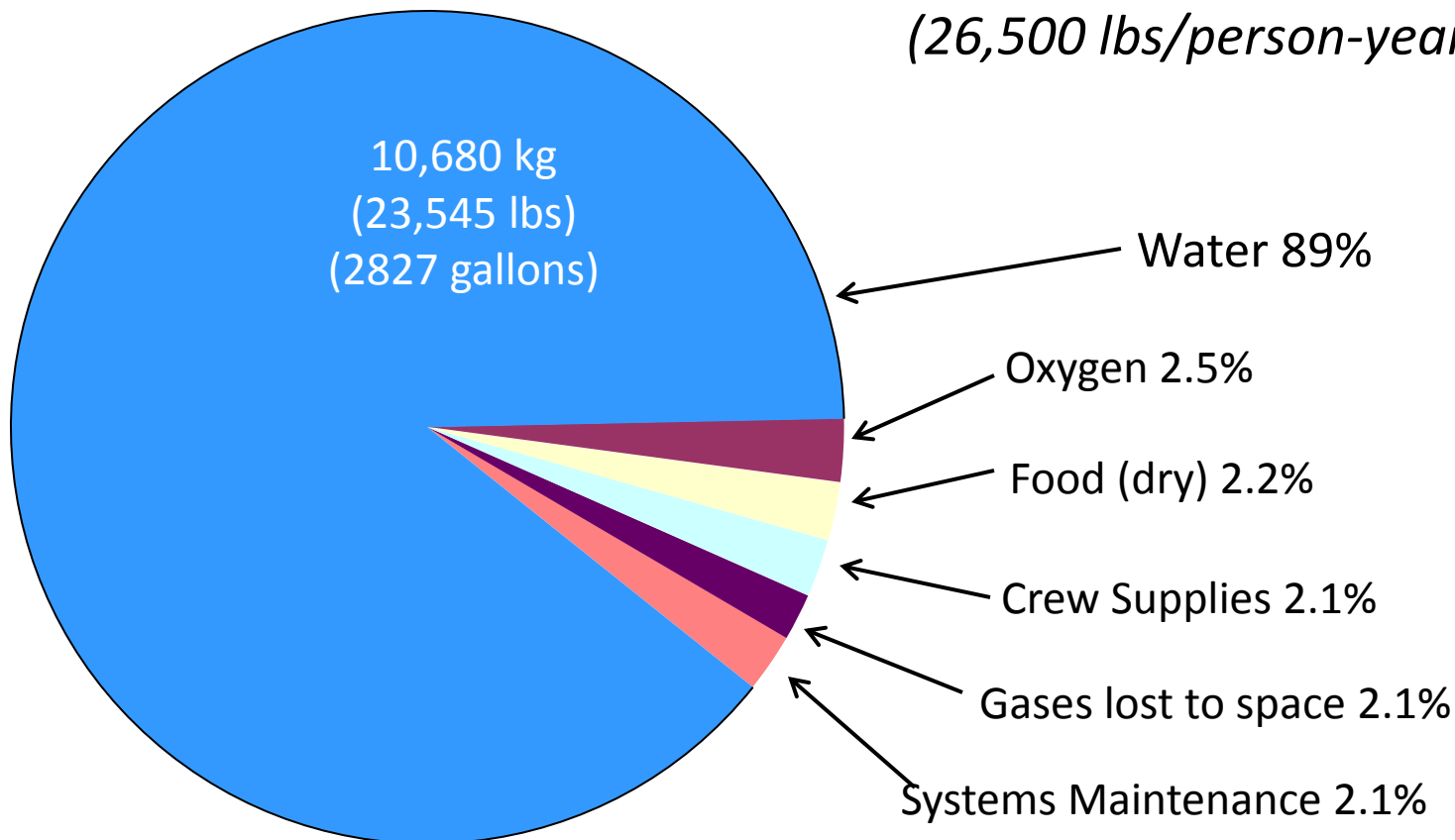
**Recovery of water from
wastewater is an enabling
technology to explore beyond
low Earth orbit**



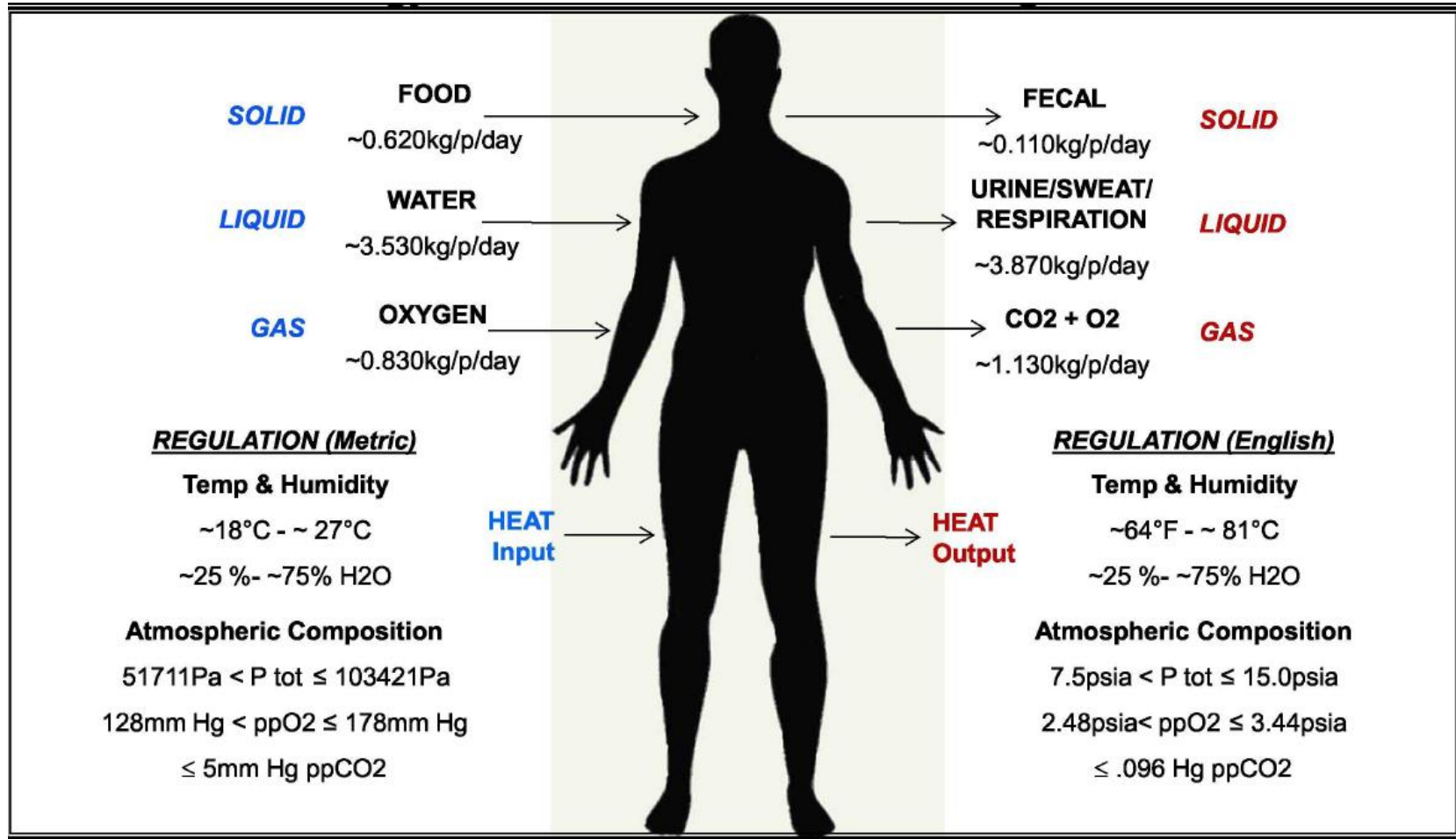
Human life support requirements



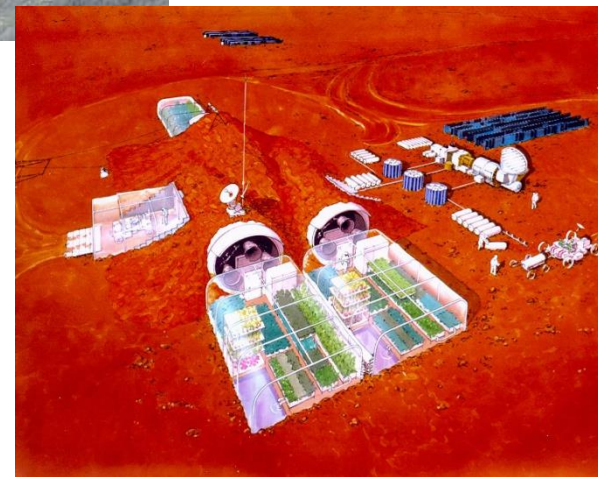
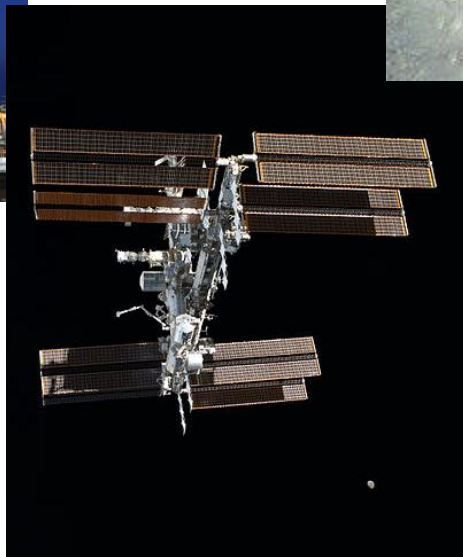
Open-loop life support system resupply mass
12,000 kg/person-year
(26,500 lbs/person-year)



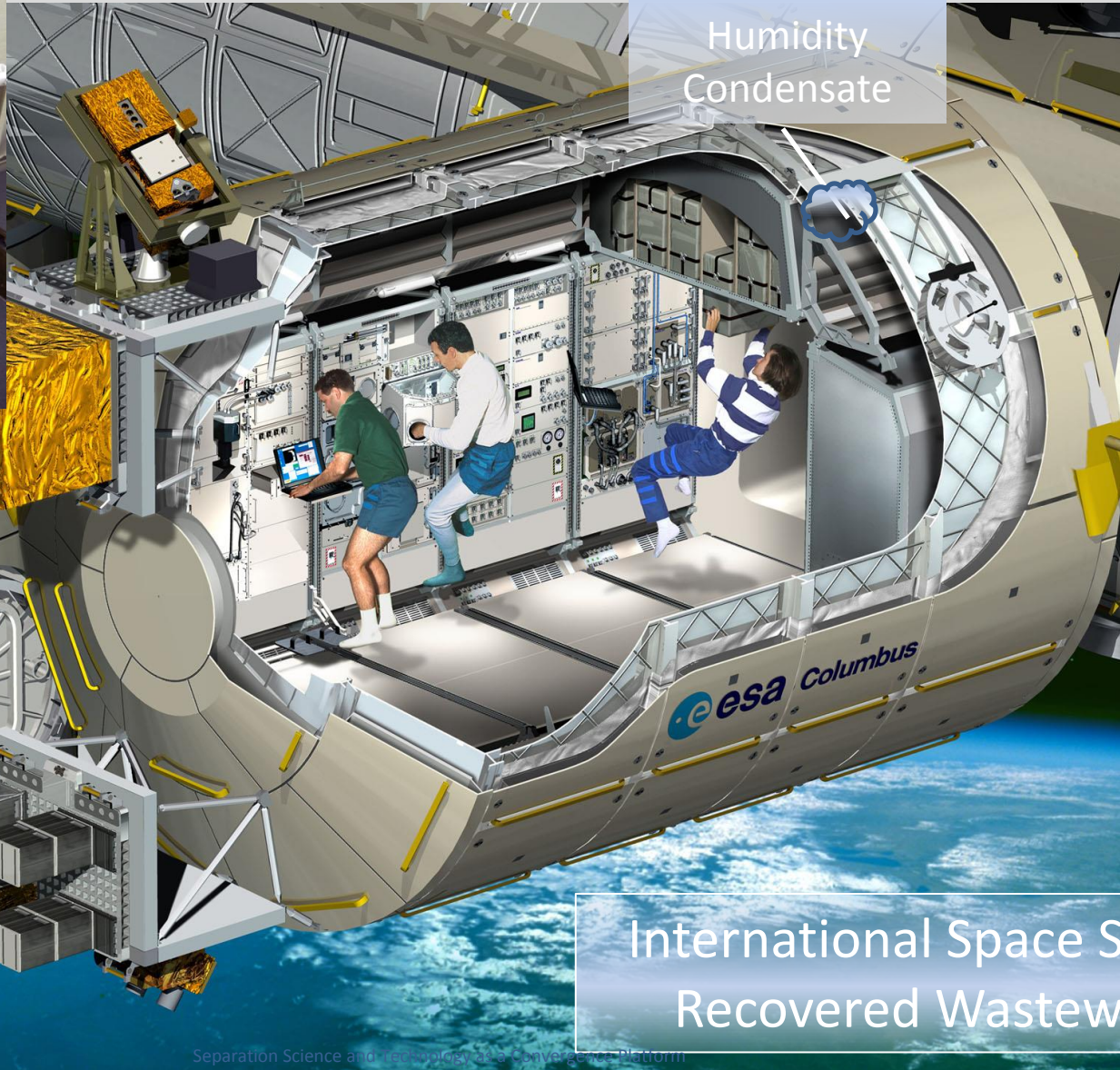
Human mass balance



Water requirements change as mission matures

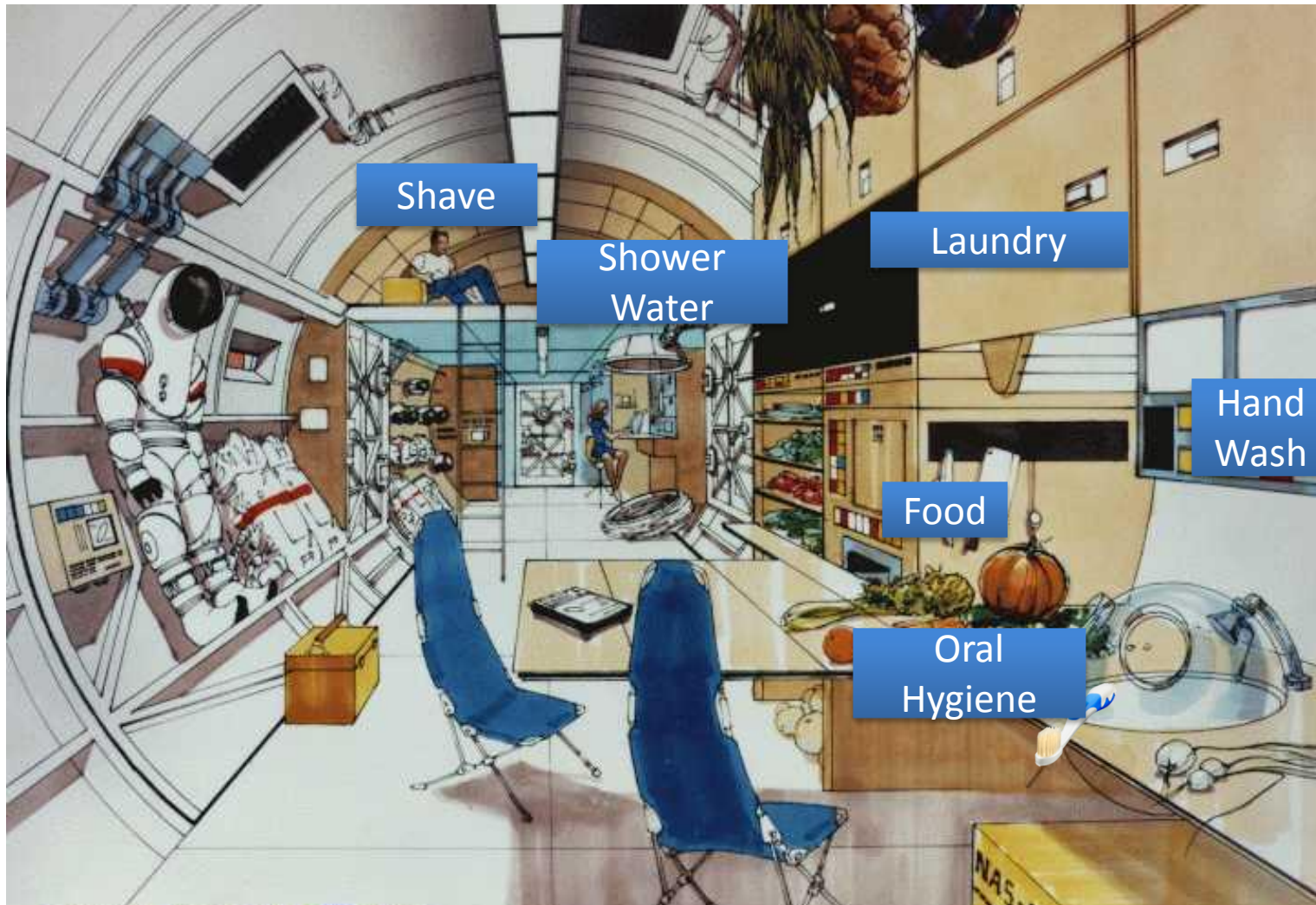


Wastewater on ISS



International Space Station
Recovered Wastewater

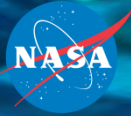
Wastewater on a planetary surface





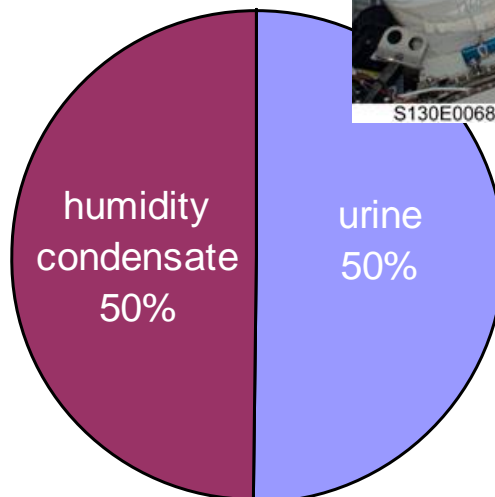
RECOVERING WATER FROM WASTEWATER

International Space Station

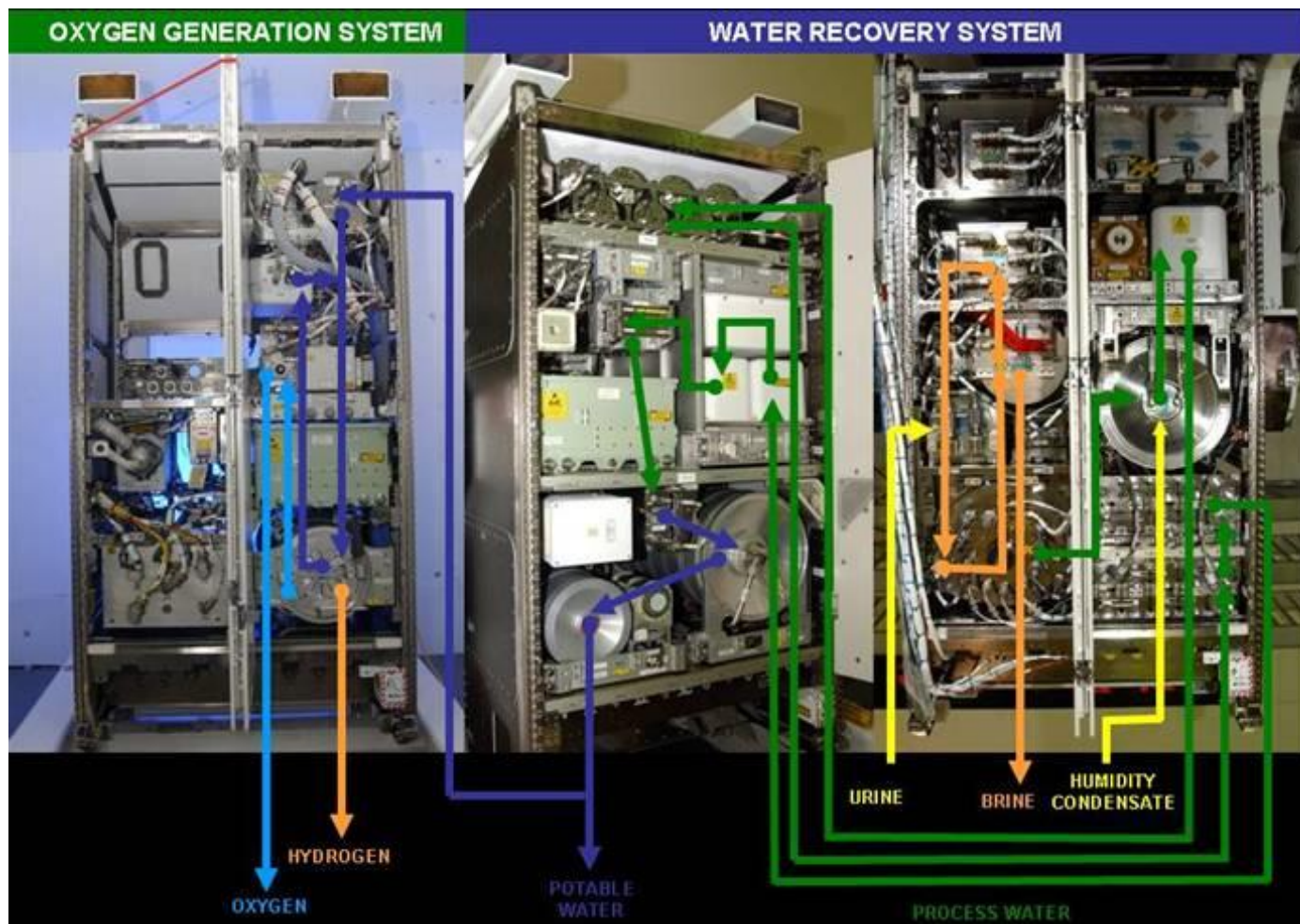


■ Recycle urine and humidity condensate

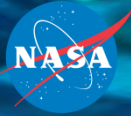
- Distillation
- Adsorption
- Ion exchange
- Catalytic oxidation
- Disinfection



ISS Life Support Systems



Stored Water



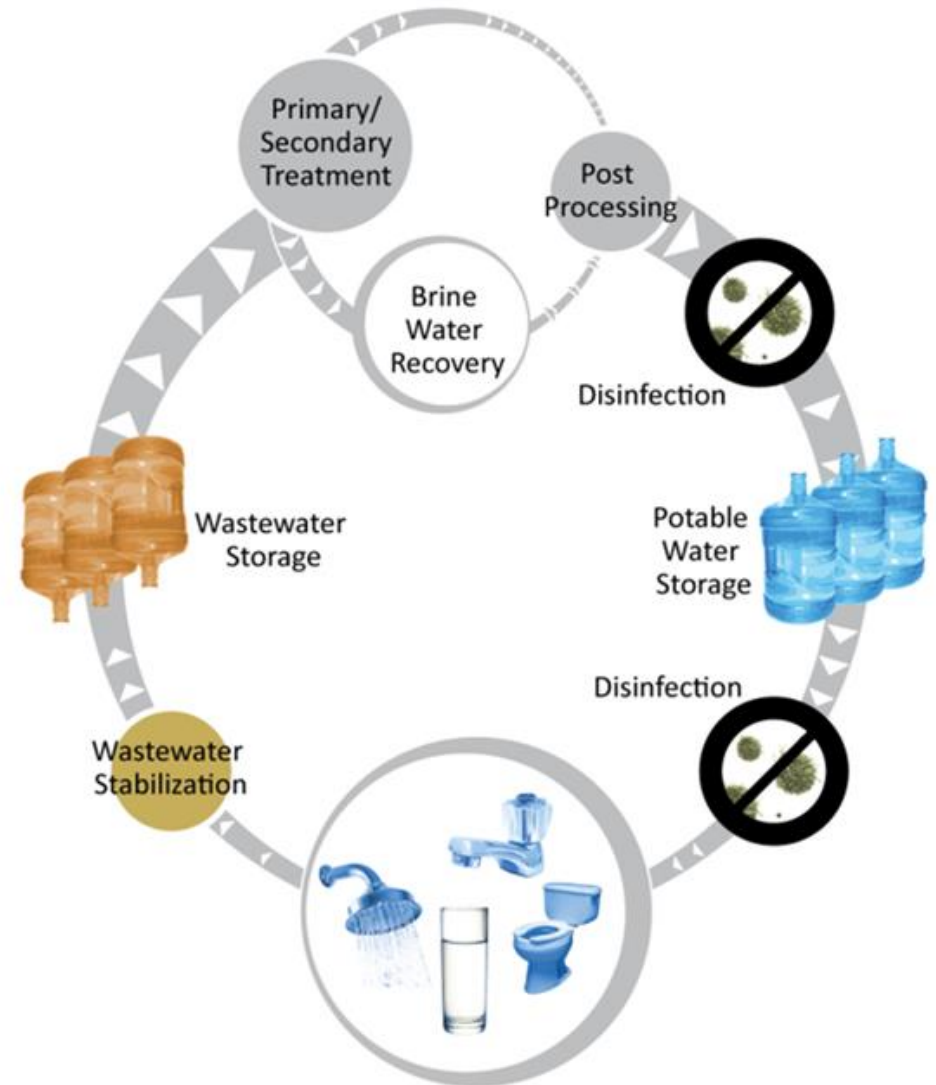
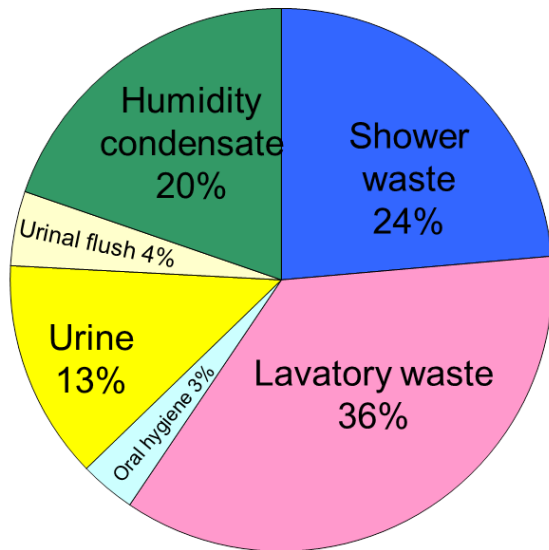
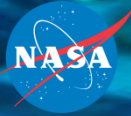
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On-orbit work with water containers

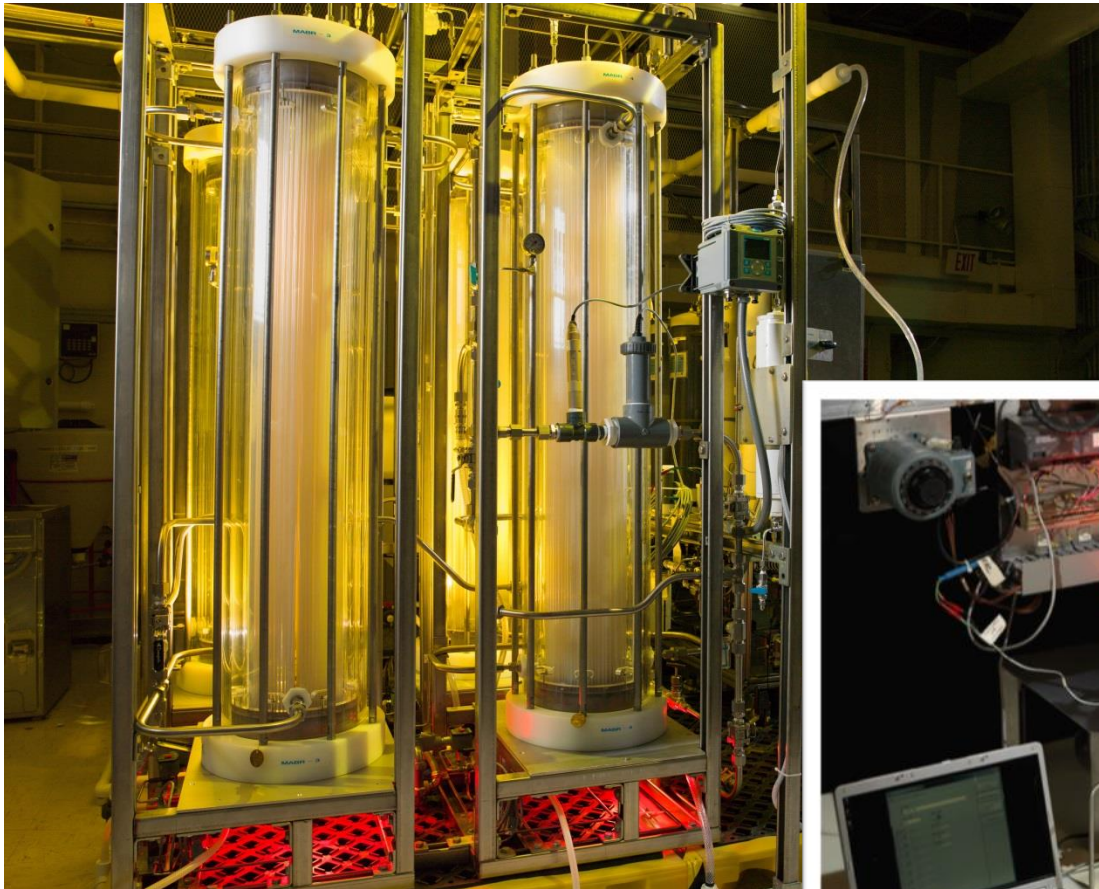
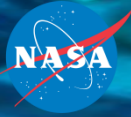


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Exploration Systems



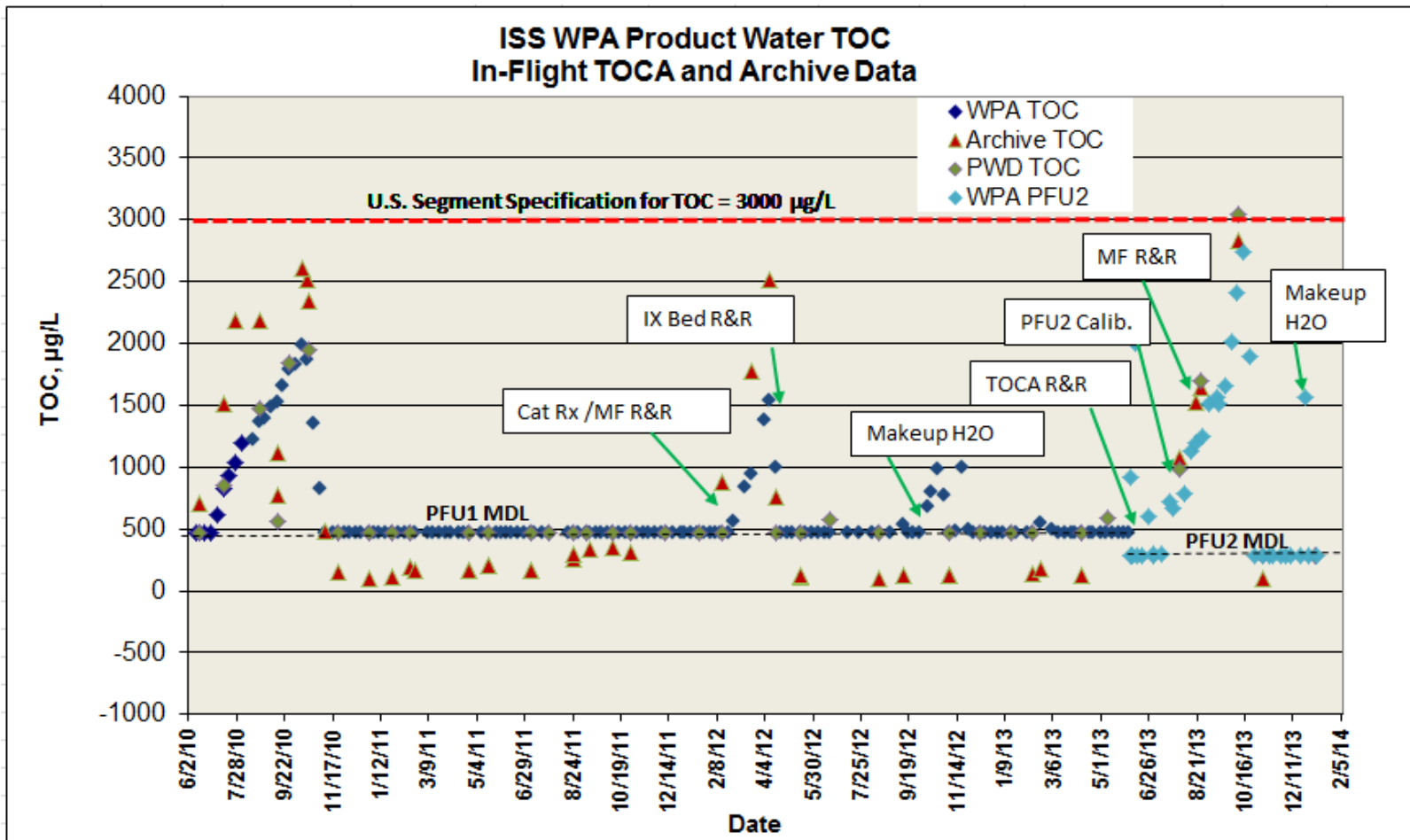
Technology for Exploration



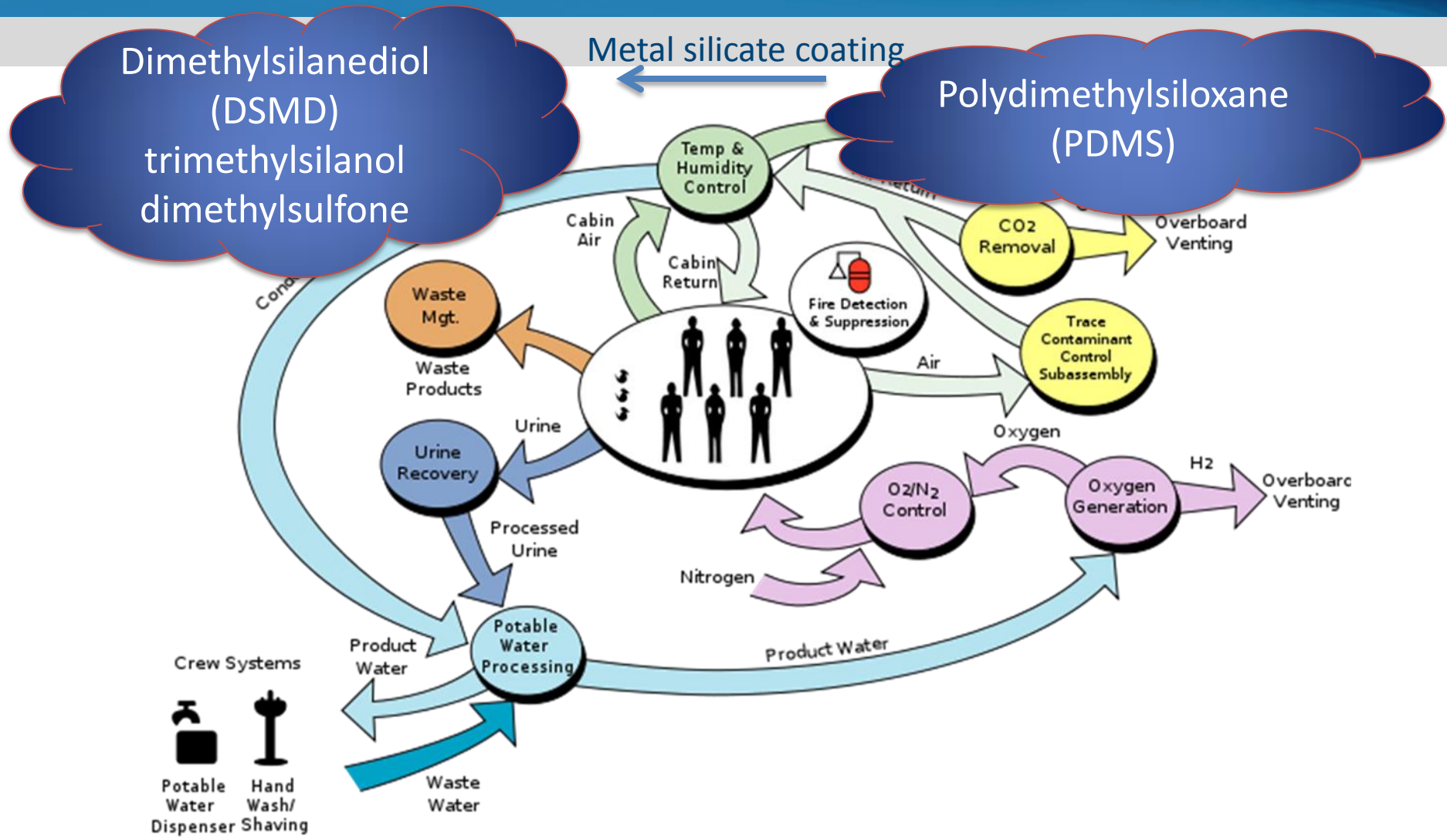


WATER QUALITY FOR HUMANS AND HARDWARE

Drinking Water Quality on ISS



Contaminant identification



Urine and solubility



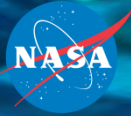
Urine solids on orbit



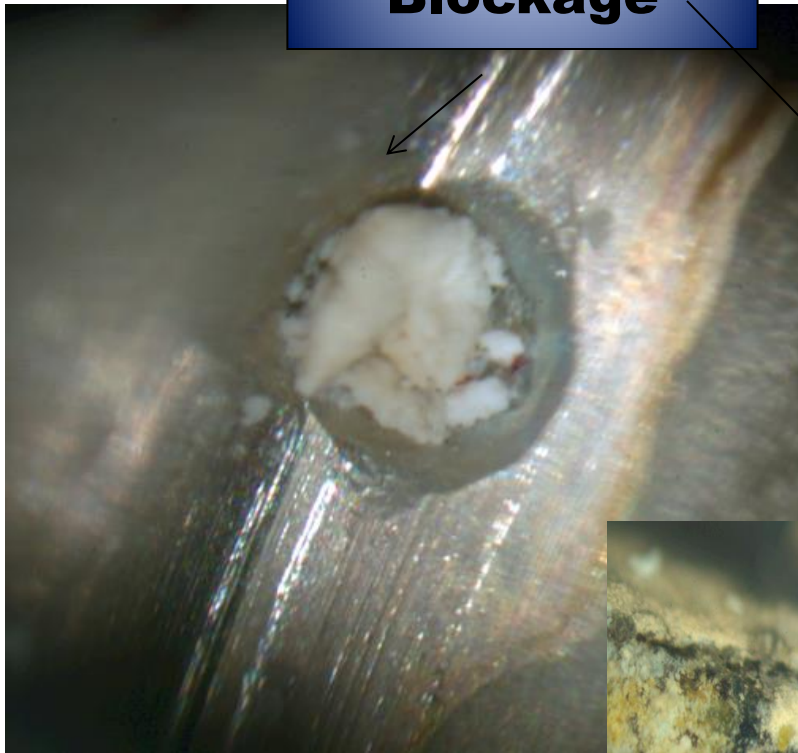
What happens when you DON'T stabilize



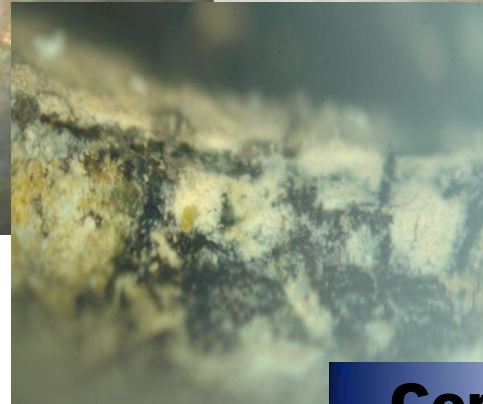
Tear Down and Inspection



**Silicate
Blockage**



**Unused Drum
for Comparison**




Corroded Braze Joint

Conclusions



- **Water impacts human health and safety in space**
- **Hardware developers need help defining WHAT water quality is required for their hardware**
- **Water recovery enables American's future space exploration**

A dynamic background image showing a water splash with numerous droplets in mid-air. The lighting is warm, with a gradient from orange to red, creating a sense of motion and energy. The water droplets are highly reflective, catching the light and creating bright highlights.

Thank you

QUESTIONS