



# Applied Quality Orbital Rehydration Assembly

Embry-Riddle Aeronautical University - Daytona Beach

Sumer Hernandez - Natalie Byrd - Karlie Jerrell - Srikar Govindarajula  
 Andres Torres-Figueroa - Alexis Binkelman - Riley Scharf - Sebastian Lopez  
 Faculty Advisor: Erik Seedhouse, Ph.D.

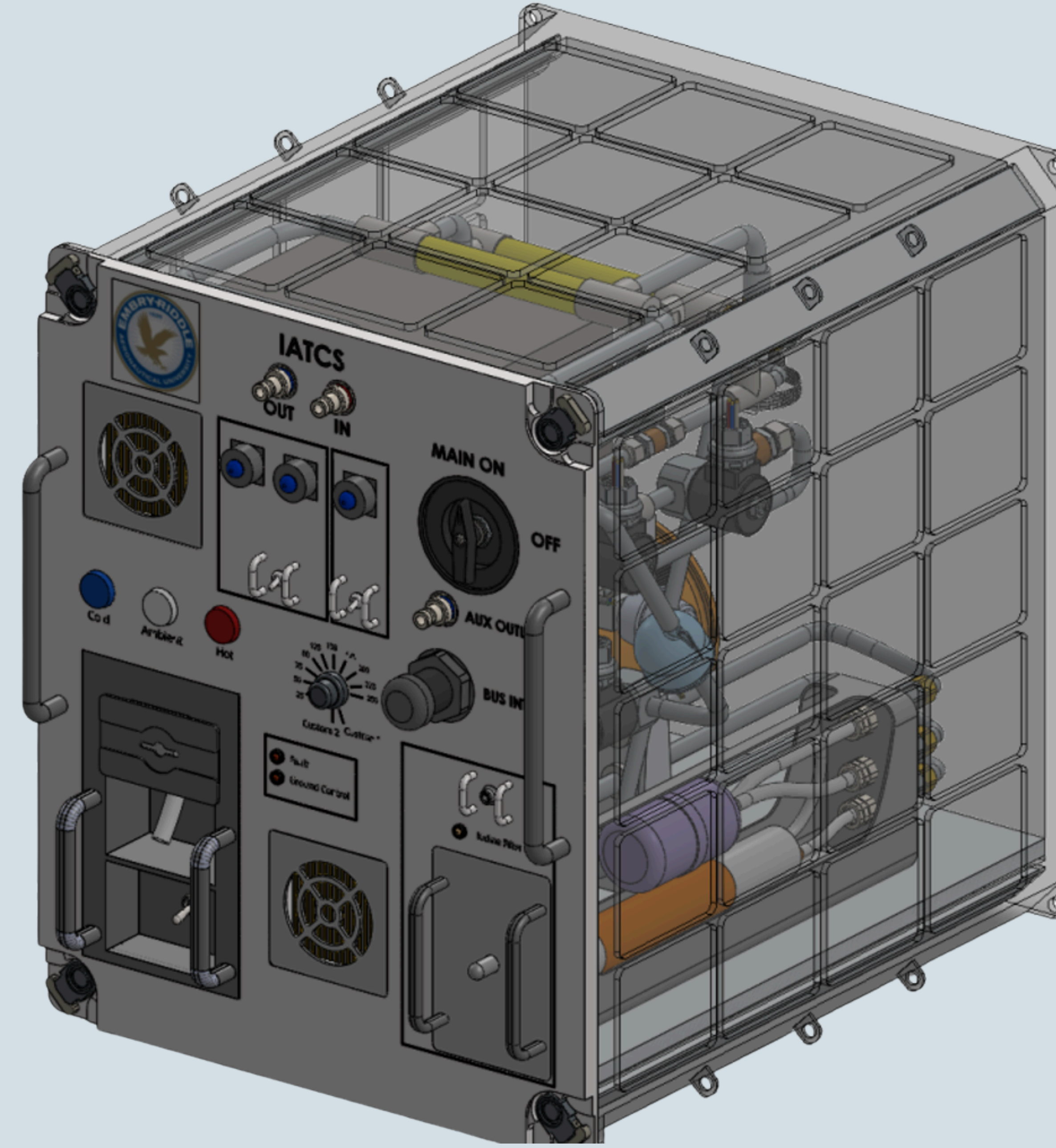
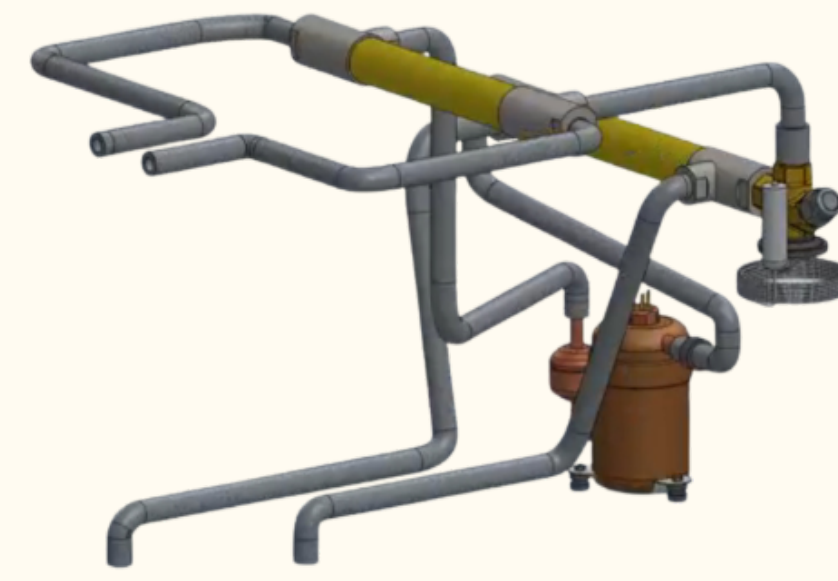


## Objective

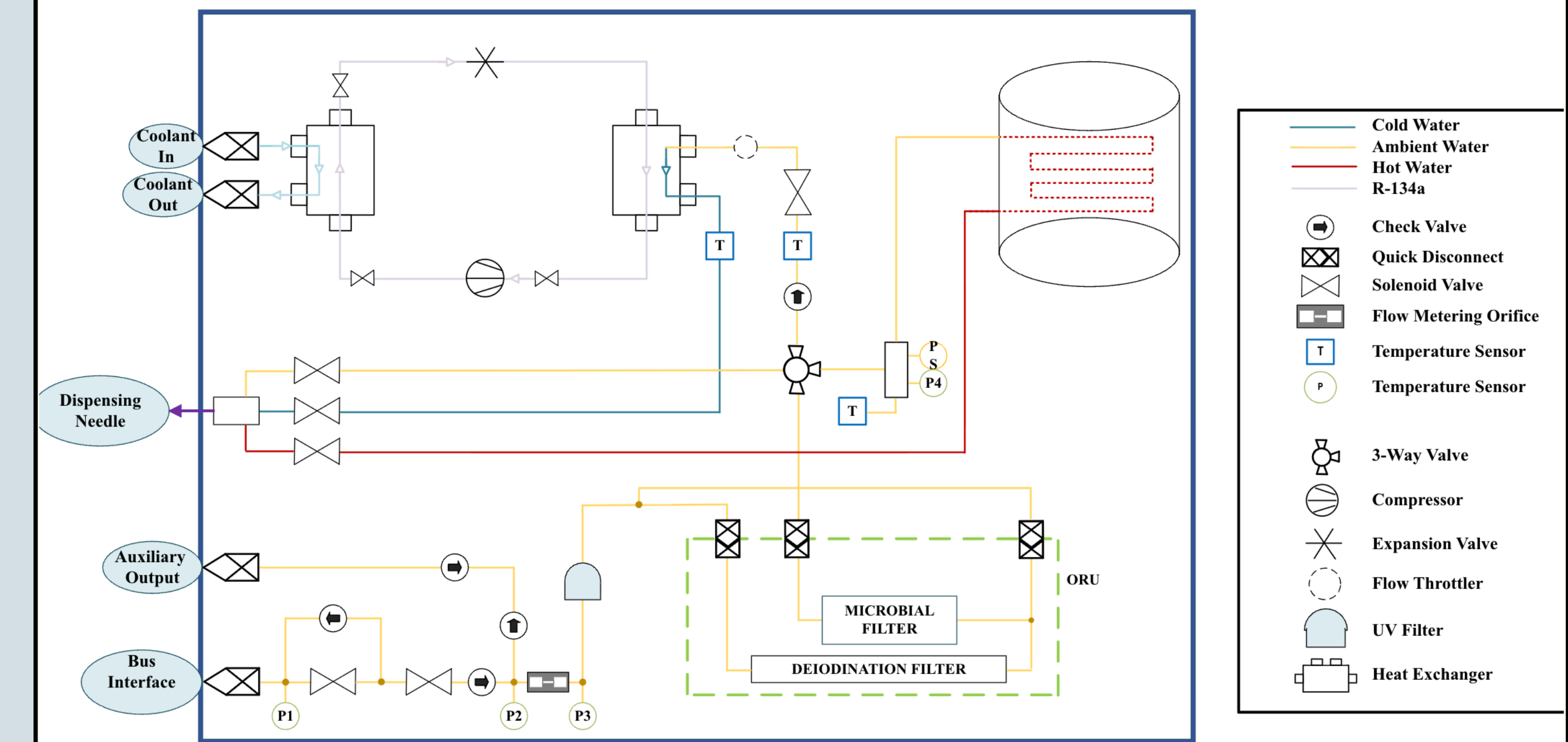
AQUORA advances the heritage Potable Water Dispenser (PWD) by adding cold-water capability for future long-duration space missions. The system provides hot, ambient, and chilled potable water on demand while maintaining separation between potable water, refrigerant, and an external thermal-control coolant. This design supports safer crew water delivery, reduced operational burden, and integration with future Environmental Control and Life Support System (ECLSS) architectures.

## Cold-Water Subsystem

- AQUORA implements the vapor-compression refrigeration cycle to rapidly cool potable water as it flows through the PWD for consumer use
- The system aims to produce a chilled water temperature between 4-8 °C alongside the existing design's hot and ambient water temperatures
- The design uses the common components related to the cycle: compressor, condenser, expansion valve, and evaporator
  - Compressor: **high P**, **high T**, vapor
  - Condenser: **high P**, **med T**, liquid
  - Expansion Valve: **low P**, **low T**, liquid
  - Evaporator: **low P**, **med T**, vapor

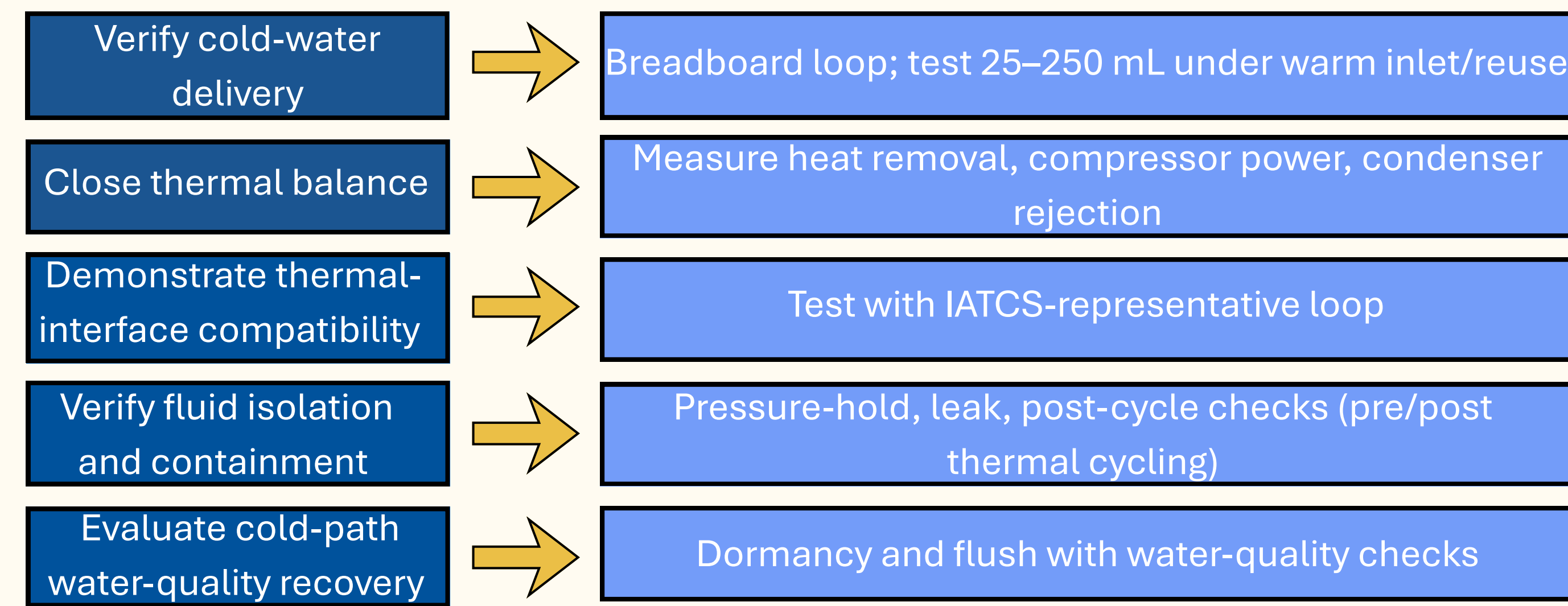


## Full System Schematic



- Cold Water
- Ambient Water
- Hot Water
- R-134a
- ⊘ Check Valve
- ⊘ Quick Disconnect
- ⊘ Solenoid Valve
- ⊘ Flow Metering Orifice
- ⊘ Temperature Sensor
- ⊘ Temperature Sensor
- ⊘ 3-Way Valve
- ⊘ Compressor
- ⊘ Expansion Valve
- ⊘ Flow Throttler
- ⊘ UV Filter
- ⊘ Heat Exchanger

## Verification and Validation



## Microbial Control

- Biofilm Challenge
  - Spacecraft water systems contain biofilm-forming organisms that could reduce water quality for astronauts such as *Burkholderia cepacia*, *Ralstonia pickettii*, *Sphingomonas spp.*, and *E. coli*
- Current AQUORA Controls
  - AQUORA retains NASA's iodine disinfection and UV monitoring systems, providing continuous microbial control
- Ultrasonic Mitigation
  - To supplement existing controls, AQUORA proposes piezoelectric ring actuators that create vibrations, which would disrupt favorable conditions for biofilm formation
- Verification and Validation
  - An AQUORA system with integrated sonication will be sent to the ISS for testing to ensure that biofilm reduction is guaranteed and that it doesn't disrupt other systems

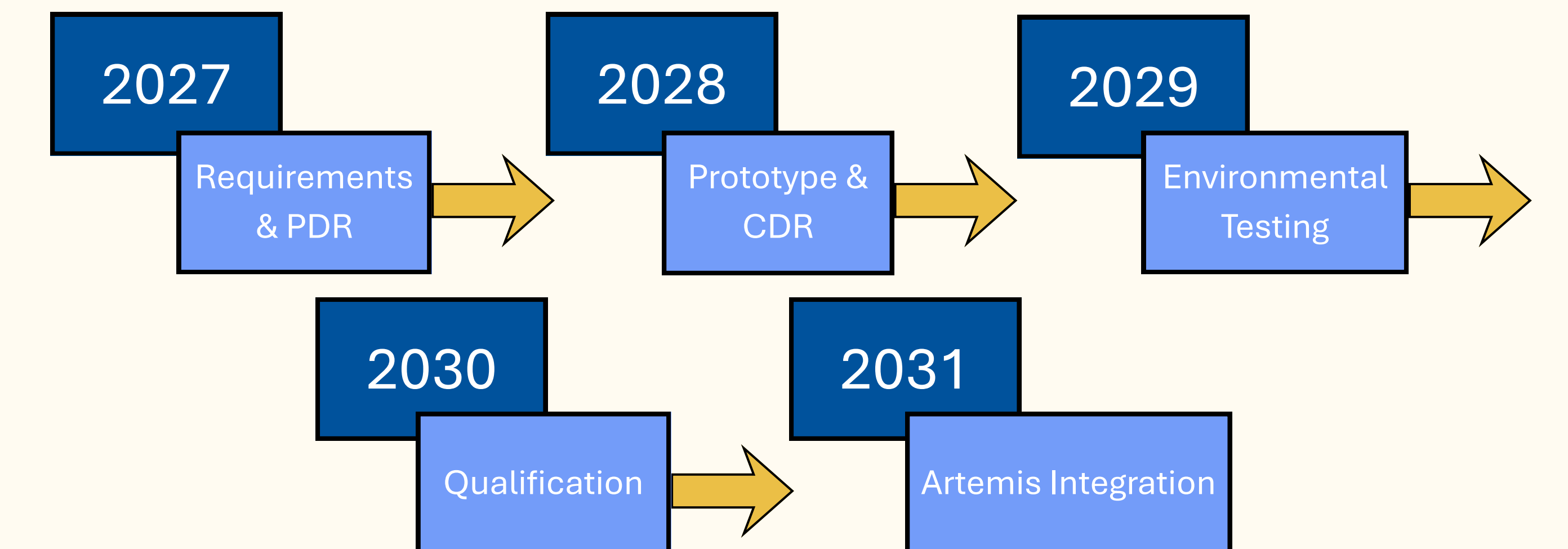
## Cold System Properties

Mass (kg)	Volume (cm <sup>3</sup> )	Power (W)
10.1	1,250	75-150

## Budget Overview

Projected Non-Recurring cost: **\$17M**  
 Recurring cost (Per unit): **\$25K**

## Timeline



## Risk & Failsafe Procedures

- Risk 1:** Cold -path microbial growth or biofilm formation
- Risk 2:** Refrigerant leakage or loss of charge
- Risk 3:** Insufficient heat rejection
- Risk 4:** Cold throughout error
- Risk 5:** Integrated hardware qualification uncertainty
- Risk 6:** Valve or Flow-control failure
- Risk 7:** Compressor Acoustic or vibration impact

	C1	C2	C3	C4	C5
5	Yellow	Red	Red	Red	Red
4	Yellow	Yellow	Yellow	R5	Red
3	Green	Green	R4	R2, R3	R1
2	Green	Green	R6	R7	Yellow
1	Green	Green	Green	Green	Green

CONSEQUENCES

Procedure	Trigger	Response	Purpose
<b>Cold Path Isolation</b>	Off-nominal temp, pressure, or sensors	Cold path disabled	Isolates faults
<b>Cold Path Flush</b>	Dormancy or water quality concern	Runs flush cycle	Restores water quality
<b>Quality Hold</b>	Contamination or failed verification	Chilled water unavailable	Prevents unsafe consumption
<b>Return-to-Service</b>	After recovery actions	Verifies path before use	Confirms nominal operation

## Innovations

- AQUORA utilizes the ISS Internal Active Thermal Control System (IATCS) coolant loop for its condenser, which parallels the ISS FRIDGE's current architecture
- Both the evaporator and condenser use shell-and-tube heat exchangers to transfer heat between two fluids
  - The evaporator cools potable water with R-134a refrigerant
  - The condenser cools R-134a refrigerant with IATCS coolant loop
- The design incorporates a flow metering device, in tandem with a temperature sensor, to throttle the potable water prior to reaching evaporator
  - Control system uses initial temperature to set the flow rate of incoming potable water
  - Allows for varying heat transfer time