

Water Recovery Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)



ABSTRACT

The AES Water Recovery Project (WRP) is advancing environmental control and life support systems water recovery technologies to support human exploration beyond low earth orbit.

For FY12-14, the AES Water Recovery Project is focused on the following:

- Cascade Distillation System (CDS): development of new primary processor for water recovery
- Brine Water Recovery: develop/test systems to recover water from urine brines
- GreenTreat: evaluate effectiveness of low toxicity urine pretreatments
- Dormancy: assess impacts of dormancy (unmanned time periods) on beyond LEO water systems
- Silver Biocide: investigate usage of silver biocide for potable water disinfection
- Water System Architecture: establish the architecture for NASA's future Water Recovery System

This project merged into AES Life Support Systems Project in FY15.

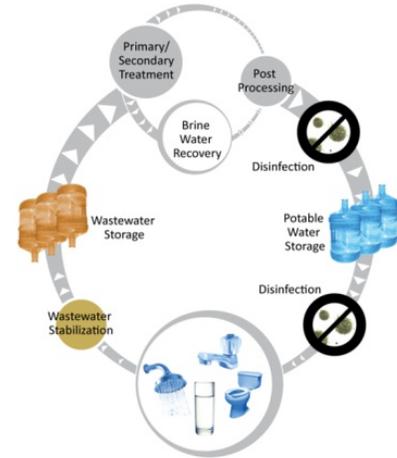
ANTICIPATED BENEFITS

To NASA funded missions:

These technologies can lead to a regenerable, reliable, closed-loop life support system that enables long-term human exploration beyond low earth orbit.

To NASA unfunded & planned missions:

These technologies can lead to a regenerable, reliable, closed-loop life support system that enables long-term human exploration beyond low earth orbit.

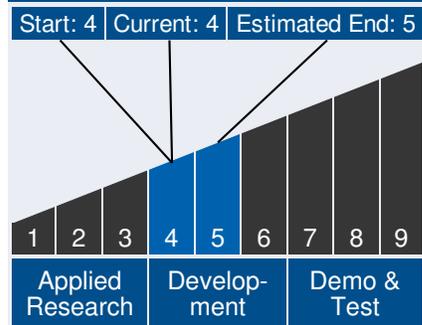


1. Water Recovery Project.

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Technology Maturity



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To other government agencies:

The maturation of life support technologies can potentially benefit Navy submarine technology needs.

To the commercial space industry:

The project advances technologies and knowledge that may allow such technologies to be provided on a commercial basis.

To the nation:

This project advances technologies that may enable human long-term space exploration on a sustainable basis.

DETAILED DESCRIPTION

The development of reliable, energy-efficient, and low-mass spacecraft systems to provide environmental control and life support (ECLS) is critical to enable long duration human missions beyond low Earth orbit (LEO). The Human Exploration Framework Team (HEFT) identified high-reliability life support systems as a required technology for destinations beyond cis-lunar space. The AES Water Recovery Project (WRP), led by Johnson Space Center (JSC) and partnered with the Ames Research Center (ARC), Glenn Research Center (GRC), and Marshall Space Flight Center (MSFC) is advancing water recovery technologies within the framework established by HEFT and the AES program.

Recycling of life support consumables is necessary to reduce resupply mass and provide for vehicle autonomy. Although an integrated life support system is made up of a variety of systems to sustain functions such as atmospheric revitalization, thermal control, and waste management, a major driver in the sizing of a life support system is the Water Recovery System (WRS). As mission durations increase, recycling of water becomes critical. Stored water is inadequate, and wastewater sources must be recycled into potable water. The state-of-the-art (SOA) WRS used on board the International Space Station (ISS) relies on a high rate of consumable use and has experienced issues with

Management Team

Program Director:

- Jason Crusan

Program Executive:

- Barry Epstein

Project Manager:

- Sarah Shull

Principal Investigator:

- Sarah Shull

Co-Investigator:

- Miriam Sargusingh

Technology Areas

Primary Technology Area:

Human Health, Life Support, and Habitation Systems (TA 6)

- └ Environmental Control and Life Support Systems and Habitation Systems (TA 6.1)
 - └ Habitation (TA 6.1.4)
 - └ Free-Water Shower for Full Body Cleansing (TA 6.1.4.1)

Secondary Technology Area:

Human Health, Life Support, and Habitation Systems (TA 6)

- └ Environmental Control and Life Support Systems and Habitation Systems (TA 6.1)
 - └ Water Recovery and Management (TA 6.1.2)
 - └ Potable Water Microbial Control (TA 6.1.2.4)

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precipitation and biofouling that have required operational and design changes. Due to these issues the recovery rate of wastewater on ISS (Condensate and Urine) is currently limited to approximately 74%.

The mission of the AES Water Recovery project is to develop advanced water recovery systems in order to enable NASA human exploration missions beyond LEO. The primary objective of the AES WRP is to develop water recovery technologies critical to near term missions beyond LEO. The secondary objective is to continue to advance mid-readiness level technologies to support future NASA missions. They also lead to further closure of the WRS, approaching the goal of 98% closure established by the Human Health, Life Support, and Habitation Systems road map (OCT TA06).

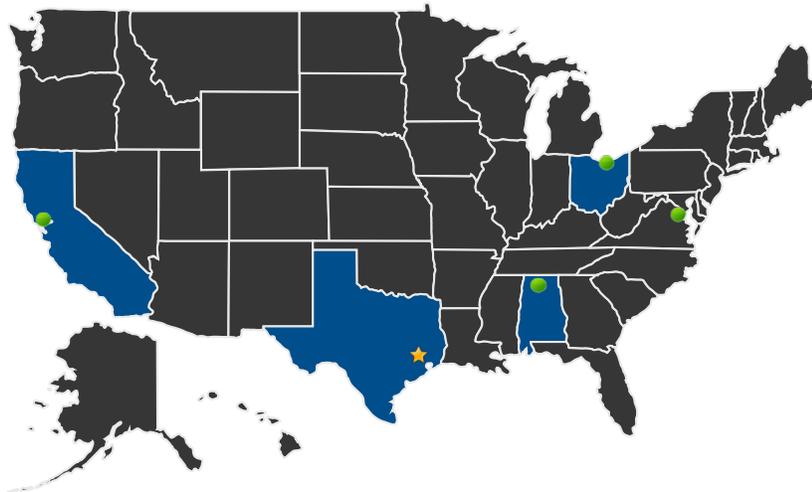
Technology Areas (cont.)

Additional Technology Areas:
Human Health, Life Support, and Habitation Systems (TA 6)

- └ Environmental Control and Life Support Systems and Habitation Systems (TA 6.1)
- └ Water Recovery and Management (TA 6.1.2)
 - └ Brine Processing (TA 6.1.2.3)

Human Exploration Destination Systems (TA 7)

U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States
With Work

★ Lead Center:
Johnson Space Center

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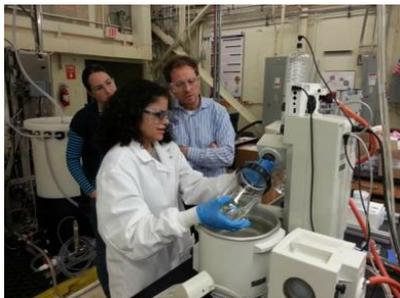
● Supporting Centers:

- Ames Research Center
- Glenn Research Center
- Johnson Space Center
- Marshall Space Flight Center
- NASA Headquarters

Other Organizations Performing Work:

- Honeywell, Inc.
- NanoMaterials Company (Malvern, PA)
- Paragon Space Development Corporation (Tucson, AZ)
- Portland State University
- Reactive Innovations, LLC (Westford, MA)
- Tietronix
- UMPQUA Research Company (Myrtle Creek, OR)
- University of Puerto Rico

IMAGE GALLERY



2. Team working on GreenTreat in the JSC Water Lab.



3. Team running Cascade Distillation System test.

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DETAILS FOR TECHNOLOGY 1

Technology Title

Water Recovery Project

Technology Description

This technology is categorized as a hardware system for manned spaceflight

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The mission of the AES Water Recovery project is to develop advanced water recovery systems in order to enable NASA human exploration missions beyond LEO. The primary objective of the AES WRP is to develop water recovery technologies critical to near term missions beyond LEO. The secondary objective is to continue to advance mid-readiness level technologies to support future NASA missions. They also lead to further closure of the WRS, approaching the goal of 98% closure established by the Human Health, Life Support, and Habitation Systems road map (OCT TA06).

Capabilities Provided

The testing and maturation of technologies by the WRP will provide an assessment of the operation of advanced technology as part of a regenerable, reliable, closed-loop life support system. In addition, the work demonstrates integrated operation of technologies essential to enable

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long-duration space flight. Combined, these features reduce the risk for other long-duration life support missions.

The key technologies selected for maturation and testing as part of the AES project in fiscal year 2014 (FY14) are the Cascade Distillation System (CDS), advancements in water chemistry, and brine treatment technologies. Cascade distillation represents a rotary distillation system design to process wastewater with a potential for greater reliability and lower energy costs than existing distillation systems. Advancements in water chemistry includes evaluating safe (e.g., less toxic) and effective means for stabilizing and storing wastewater (showers, urination, etc.) for long periods before treatment. More effective means of maintaining potable water quality will be evaluated. In addition, brine dewatering treatment technologies will be evaluated with the objective of achieving 98% water recovery.

Potential Applications

Advanced water recovery systems can enable NASA human exploration missions beyond LEO. The primary objective of the AES WRP is to develop water recovery technologies critical to near term missions beyond LEO. The secondary objective is to continue to advance mid-readiness level technologies to support future NASA missions. They also lead to further closure of the WRS, approaching the goal of 98% closure established by the Human Health, Life Support, and Habitation Systems road map (OCT TA06).

Performance Metrics

Metric	Unit	Quantity
CDS average water recovery from ISS analog wastewater	%	93
Wastewater and concentrated brine toxicity rating	Toxicity Rating	1