National Aeronautics and Space Administration

# Environmental Control and Life Support System (ECLSS)

Earth's natural life support system provides the air we breathe, the water we drink and other conditions that support life. For deep space missions of the future, it is essential to preserve as many natural resources as possible. Quick resupply of air and water is not possible during deep space missions, given the distances involved. NASA's Marshall Space Flight Center in Huntsville, Alabama, is responsible for the design, construction and testing of regenerative life support hardware for the International Space Station, known as the Environmental Control and Life Support System.

**Providing Clean Water and Air**

ECLSS includes three key components — the Water Recovery System, the Air Revitalization System and the Oxygen Generation System. These systems were jointly designed and tested by the Marshall Center and industry partners including UTC Aerospace Systems, formerly Hamilton Sundstrand Space Systems International, Boeing, Lockheed Martin, and Honeywell, Inc. They are packaged into four refrigerator-sized racks in the U.S. Tranquility module on the station. A second Air Revitalization System is in the U.S. Destiny Laboratory.

The **Water Recovery System** provides clean water by reclaiming wastewater (including water from crew members' urine), cabin humidity condensate, and water from the hydration system inside crew members' Extra Vehicular Activity suits. The recovered water must meet stringent purity standards before it can be used to support crew, extravehicular and payload activities.

**European Space Agency astronaut Frank De Winne exchanges the Distillation Assembly of the Urine Processor Assembly on the International Space Station which was designed and built at NASA's Marshall Space Flight Center. This device helps filter and purify crew waste in space, conserving more water and reducing the amount of resupply the astronauts require from Earth. (NASA)**

The **ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM (ECLSS)** for the space station performs several functions:

- Provides oxygen for breathing
- Removes carbon dioxide from the cabin air
- Recovers and recycles oxygen from carbon dioxide to resupply the crew
- Filters particulates and microorganisms from the cabin air and maintains cabin pressure, temperature and humidity levels
- Removes volatile organic trace gases, such as ethanol, that are colorless, odorless and can build up over time
- Distributes cabin air between each room, or module, of the station;
- Provides potable water for consumption, food preparation and hygiene
- Purifies recycled water from multiple sources back to potable water

Water produced by the urine processor is combined with all other wastewaters and delivered to the water processor for treatment. The water processor sends the water through a series of multifiltration beds and a catalytic oxidizer for purification. The water purity is checked by electrical conductivity sensors in the systems. Unacceptable water is reprocessed, and clean water is sent to a storage tank, ready for the crew to use. Currently, the Water Recovery System is capable of recovering and recycling about 90 percent of the water on station.

Each astronaut needs about a gallon of water per day for consumption, food preparations and hygiene — brushing teeth and shaving.

The **Air Revitalization System** is dedicated to cleaning the circulating cabin air. This involves removing trace contaminants produced by electronics, plastics and human off-gassing, including carbon dioxide exhaled by the crew during normal respiration. Trace contaminants are removed

**ECLSS Facts**

- The Environmental Life Support System for water recycling has been operating on the space station since 2008.
- Astronauts need to drink a half gallon of water each day — we all do!
- Oxygen on the ISS comes from a process called "electrolysis," which involves using an electrical current generated from the station's solar panels to split water molecules into hydrogen and oxygen gas.
- ECLSS reclaims 90 percent of all astronaut sweat and urine.
- This technology has been adapted on Earth to aid remote locations or places devastated by natural disaster that do not have access to clean drinking water.

by flowing cabin air through three separate units including an activated charcoal bed, a catalytic oxidizer and a lithium hydroxide bed. Carbon dioxide is removed using molecular sieves, materials that separate and capture gases based on their size.

The **Oxygen Generation System** produces oxygen for the crew to breathe. The system consists of the oxygen generation assembly and the carbon dioxide reduction assembly. The oxygen generation assembly is composed of the cell stack, which electrolyzes, or breaks apart, water provided by the Water Recovery System, yielding oxygen and hydrogen as byproducts. The oxygen is delivered to the cabin atmosphere while the hydrogen is either vented into space or fed to the carbon dioxide reduction assembly. The assembly uses that hydrogen along with carbon dioxide exhaled by the crew in a Sabatier reactor. The byproducts of that process are methane (which is released into space) and water for use by the crew.

## Future

Deep space missions in the future will not be able to waste any resources. It will not be possible to resupply air and water due to the distances involved, nor will there be room to take it along on a spacecraft due to the volume and mass of consumables required for a voyage of months or years. We are also improving the efficiency and reliability of the current system so we do not have to send as many spare parts. Marshall and other NASA centers are working to develop regenerative life support hardware to maximize recycling of water and oxygen that will sustain life and allow humans to travel deeper into space than ever before.

**NASA astronaut Kjell Lindgren brews a cup of coffee using the Capillary Beverage Cup on the International Space Station. The Environmental Control and Life Support System on the orbiting laboratory helps recycle the precious commodities to sustain life in space, including air to breathe and water to make coffee and for other uses on the station. (NASA)**

**European Space Agency astronaut Samanta Cristoforetti exercises on the Cycle Ergometer with Vibration Isolation and Stabilization (CEVIS) on the International Space Station. Sweat and carbon dioxide generated by crew members in space is recycled into usable water and breathable air by the Environmental Control and Life Support System. (NASA)**

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