



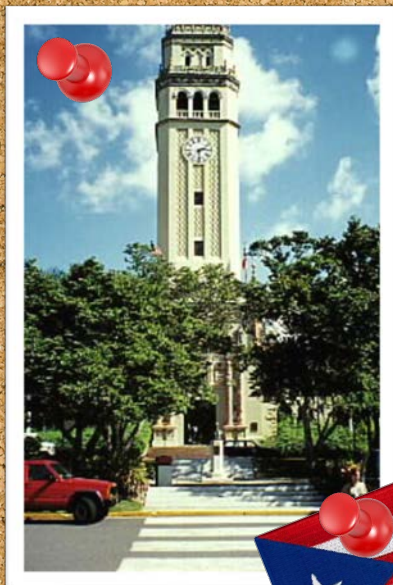
EXPLORE HUMANS *in* SPACE

Monsi Roman

Program Manager, NASA's
Centennial Challenges









Missions: 1 Year to 6 months



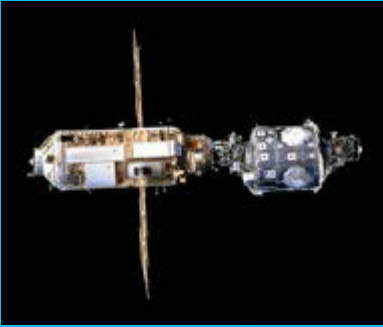
Missions: Years?



Missions: 14- Days



1998



Zarya/Unity

2001



Destiny

Some
Assembly
Required

2007



Harmony

2008



Columbus



Kibo

2010

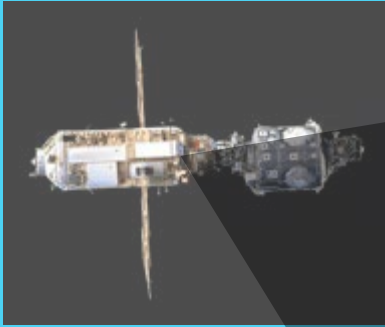


Tranquility



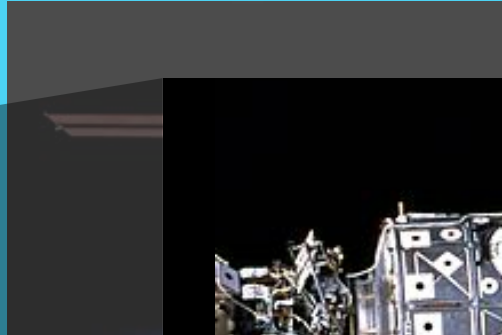
Assembly Complete

1998



Zarya/Unity

2001



Destiny

Some
bly
ed



Node 1 Unity Module
Ventilation/Filtration

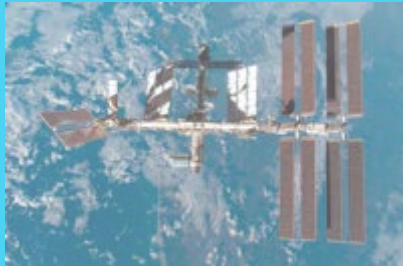
0 Permanent Crew

2007



Harmony

2008



Columbus

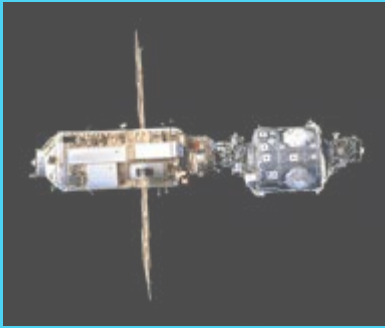


JEM



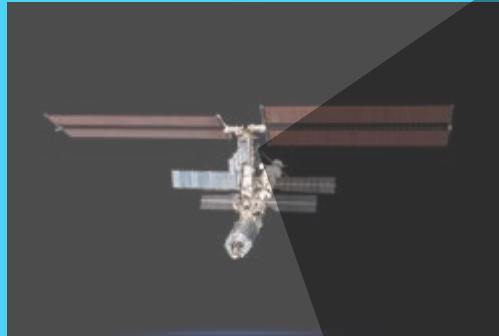
Assembly Complete

1998



Zarya/Unity

2001



Destiny

2008



Columbia



JEM

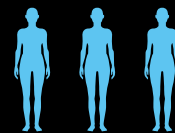
2010



Tranquility



Destiny/US Laboratory
Atmosphere Revitalization



3 Crew

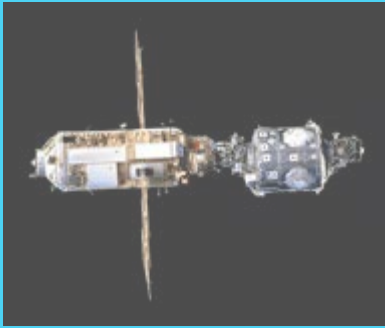


ny



lete

1998



Zarya/Unity

2001



Destiny

Some

2007



Harmony

2008



Columbus



JEM



Harmony Node 2
Crew Quarters

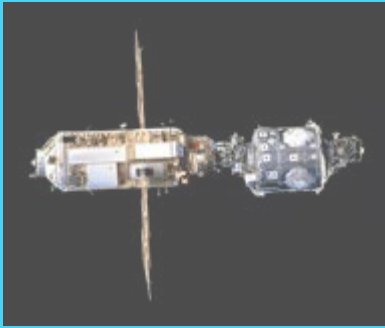


4 Crew



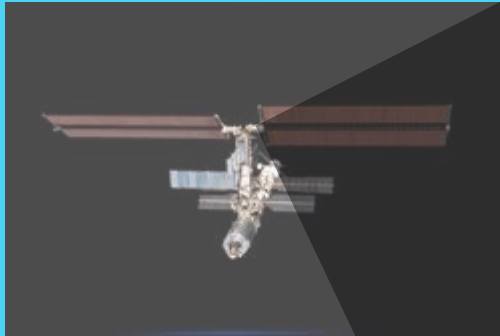
Assembly Complete

1998



Zarya/Unity

2001



Destiny

S
Ass
Re

2008



Columbus



JEM

2010



Tranquility



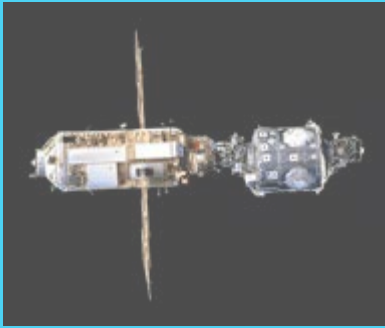
Destiny/US Laboratory
Oxygen Generation
Assembly added 2006



4 Crew

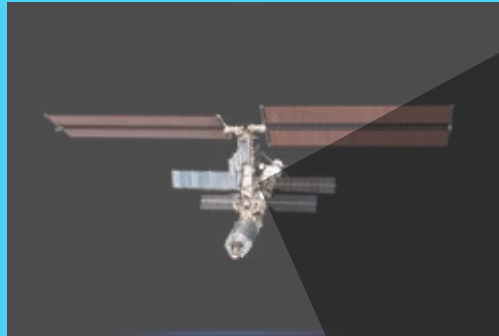


1998



Zarya/Unity

2001



Destiny

2008



Columbus



JEM

2010

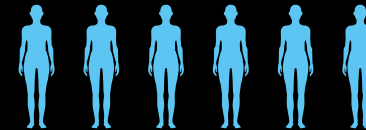


Tranquility

2007



Destiny/US Laboratory
Water Recovery System added 2008



6 Crew





Tranquility Node 3
OGS & WRS relocated here;
Sabatier added 2010
Double toilet stall 2019



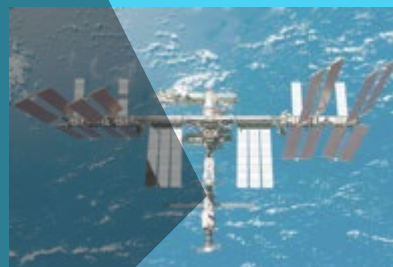
Some Assembly Required

2007



Harmony

2010

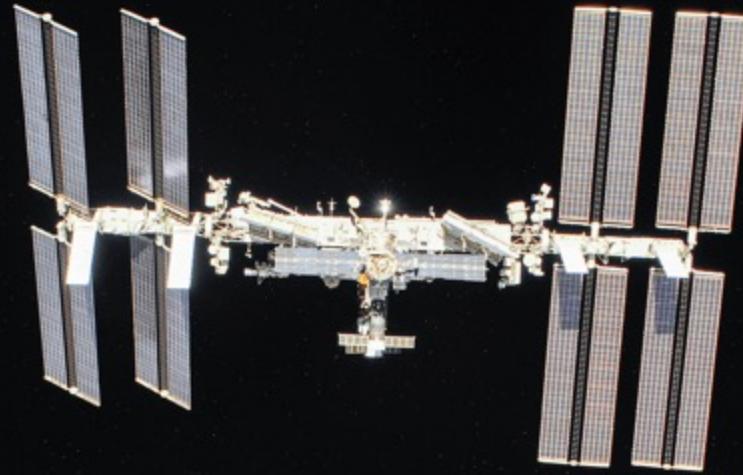


Tranquility



Assembly Complete



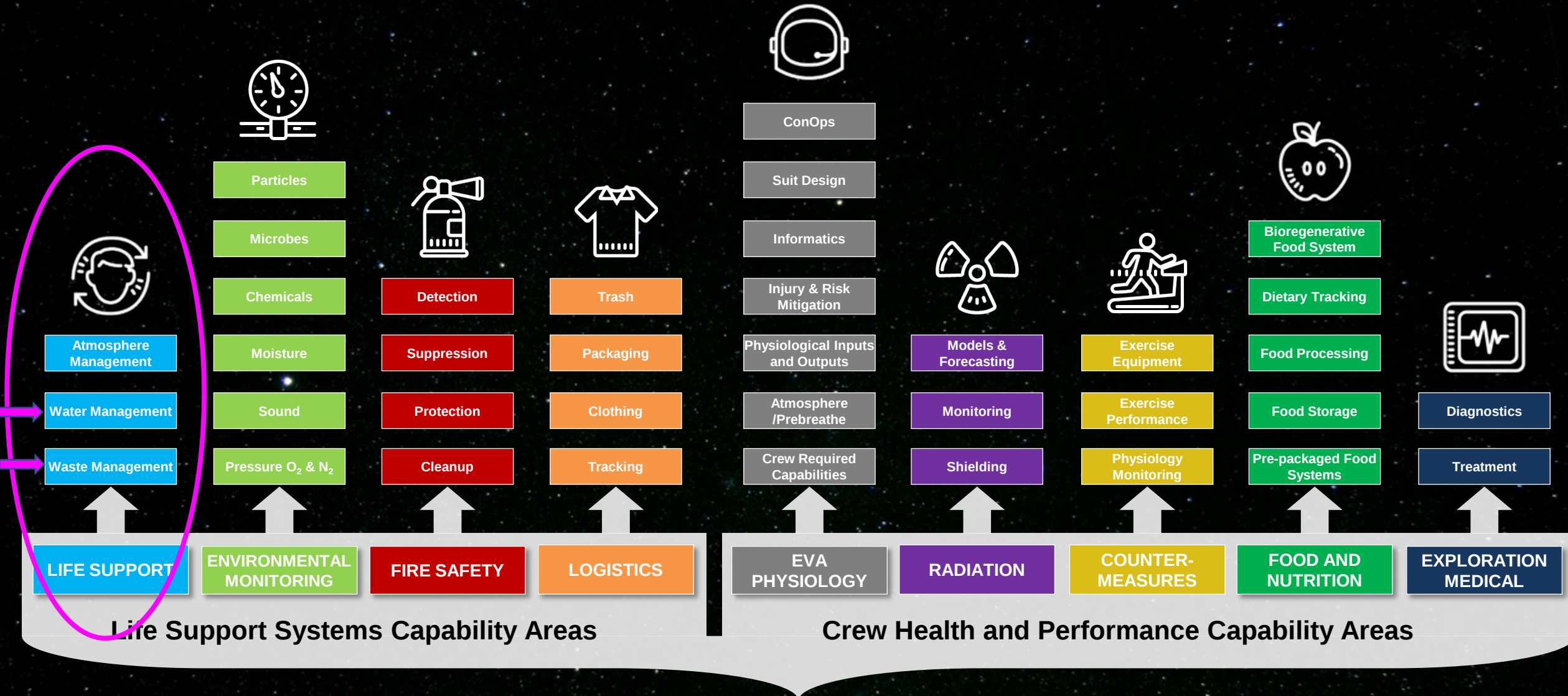


Environmental Control and Life Support Systems (ECLS)



Habitation Systems Capabilities

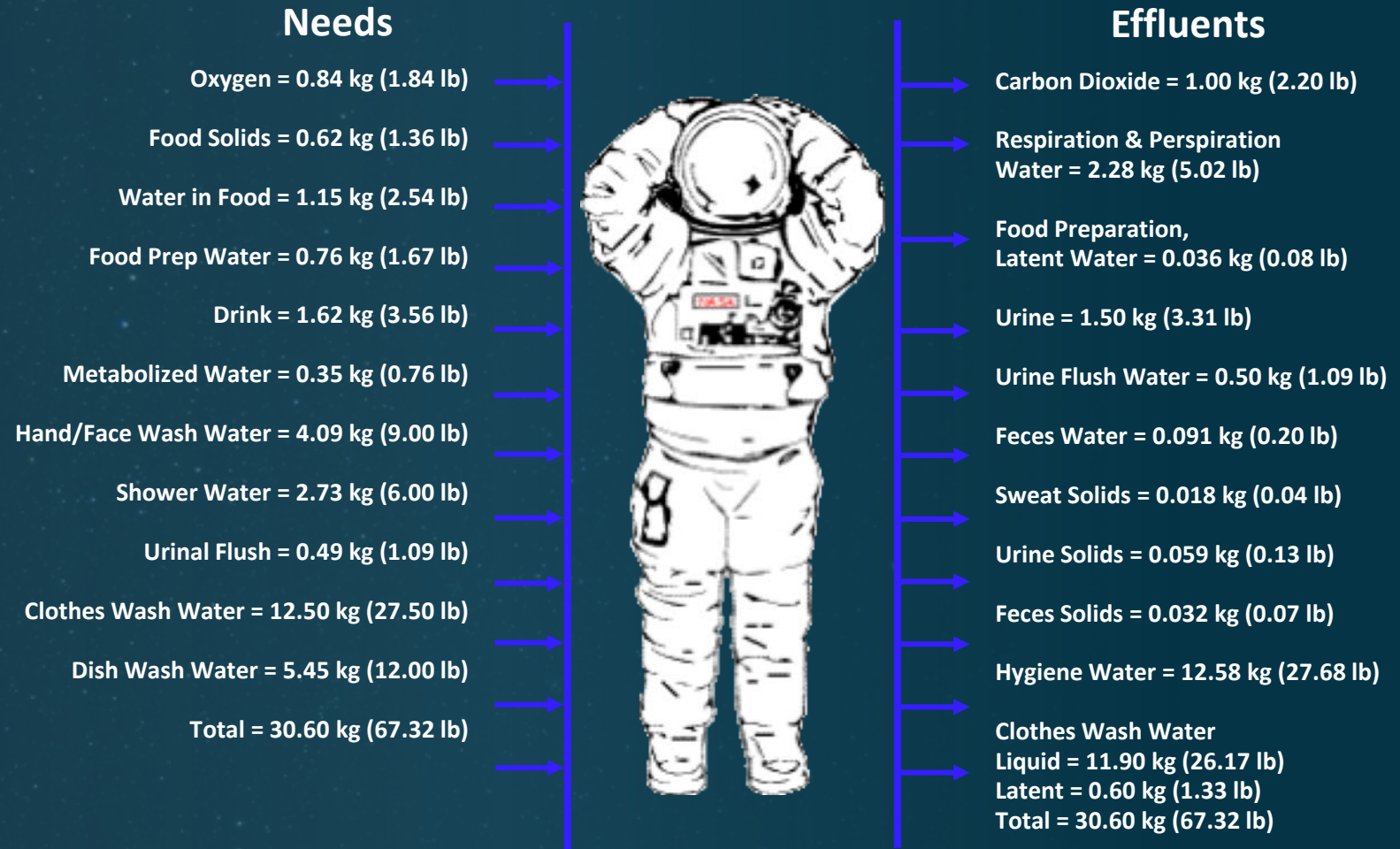
National Aeronautics and
Space Administration



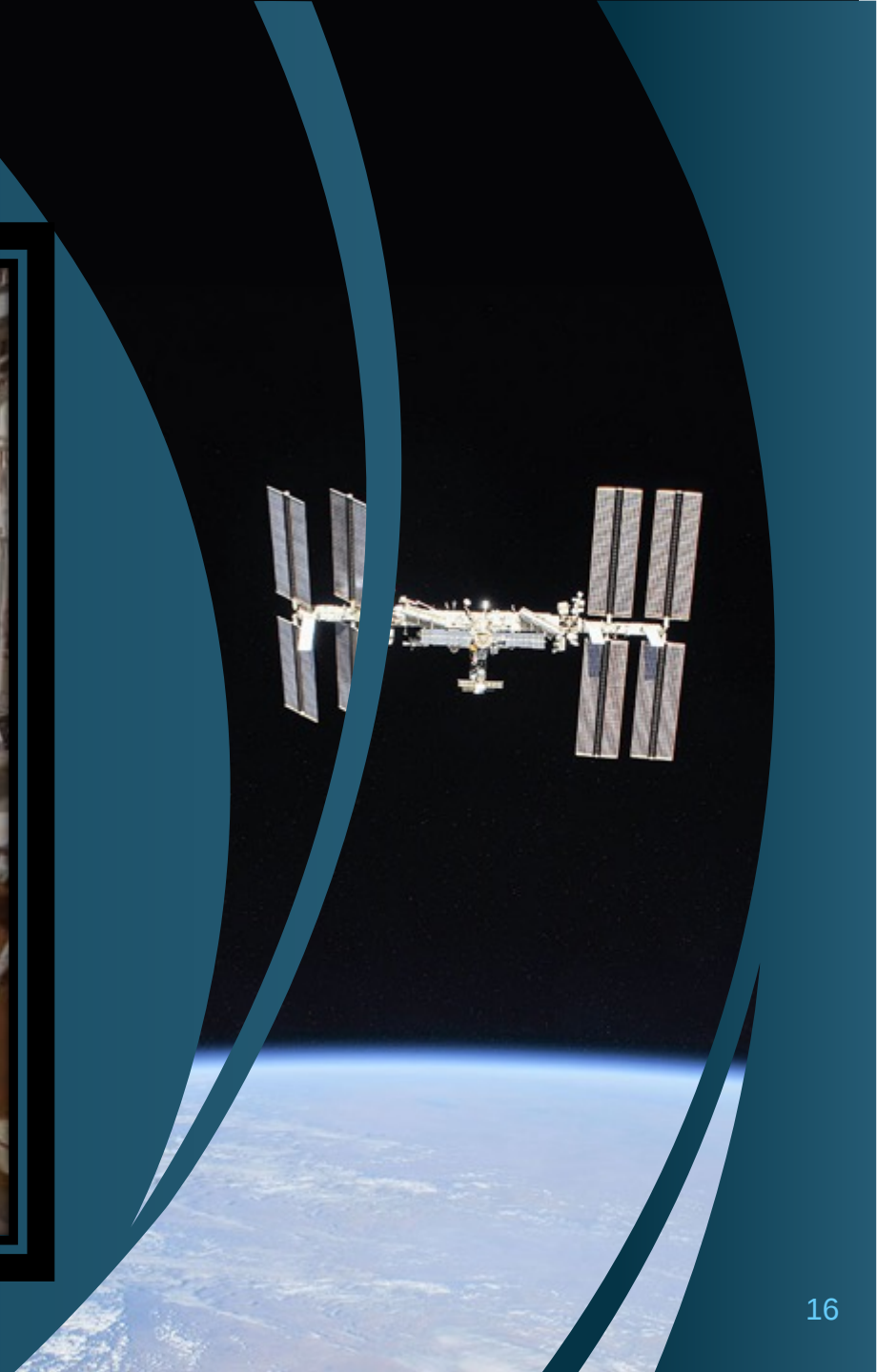
Habitation Systems

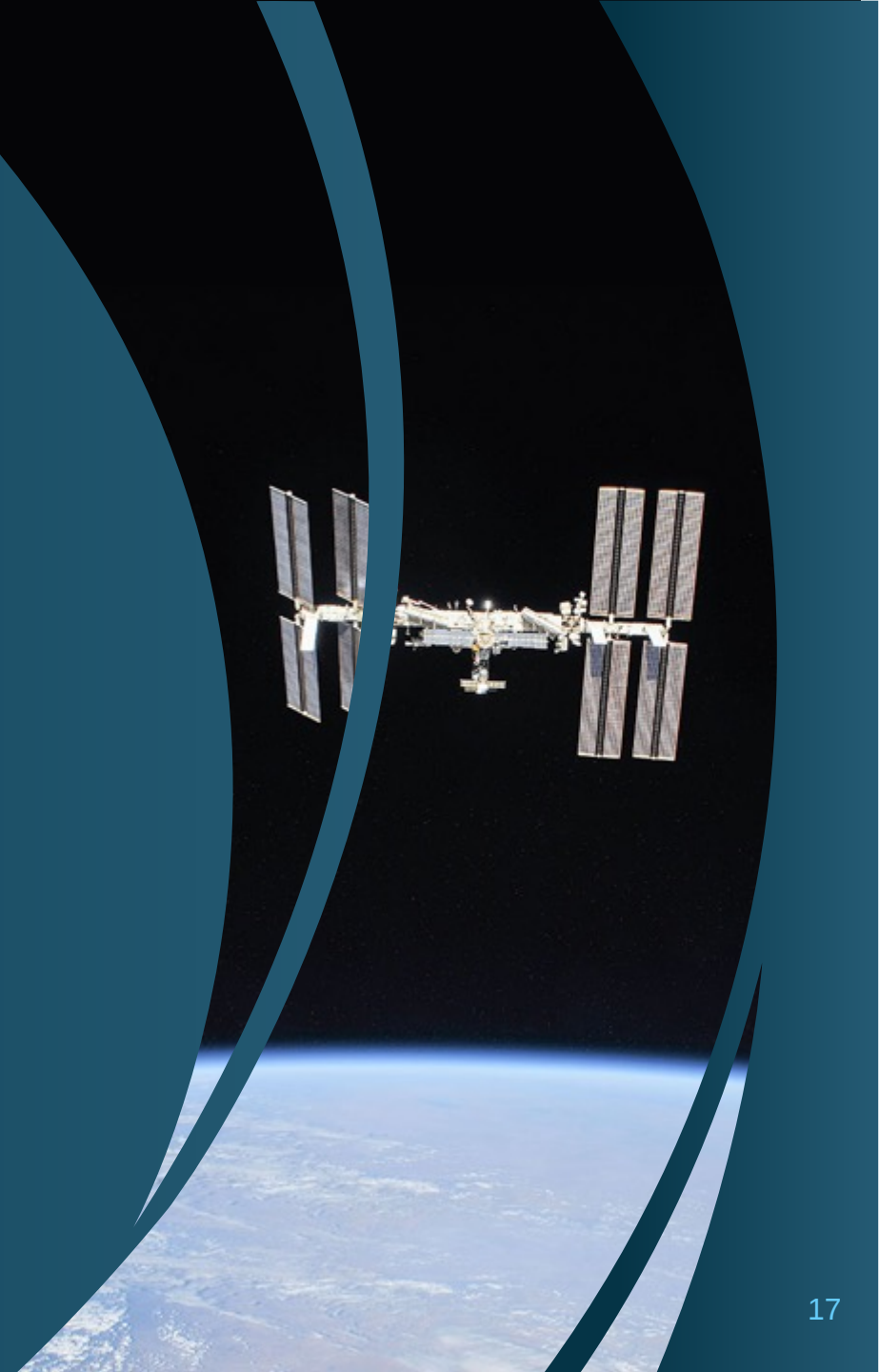
Environmental Control and Life Support Systems

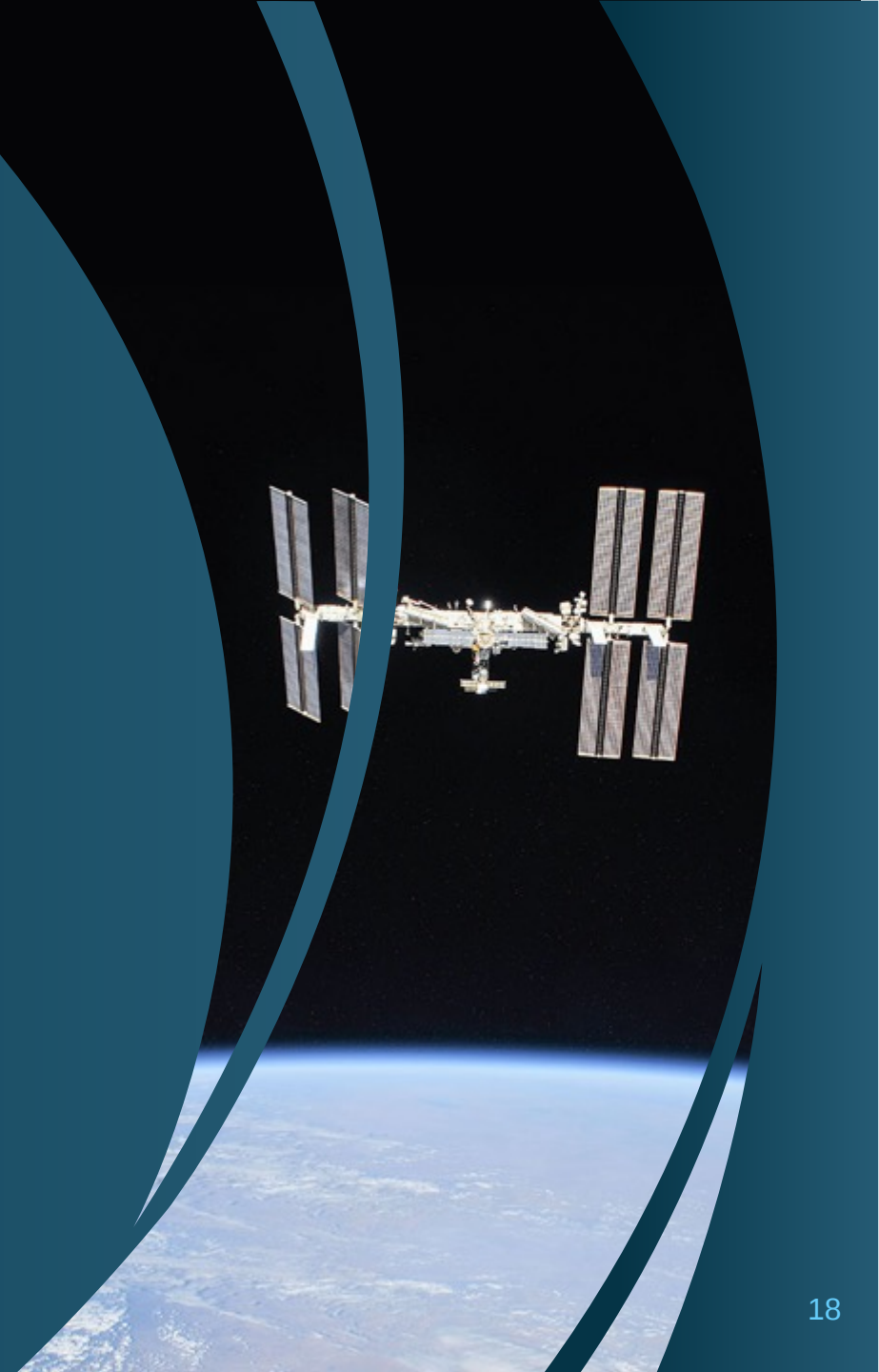
Human Needs and Effluents Mass Balance (per person per day)

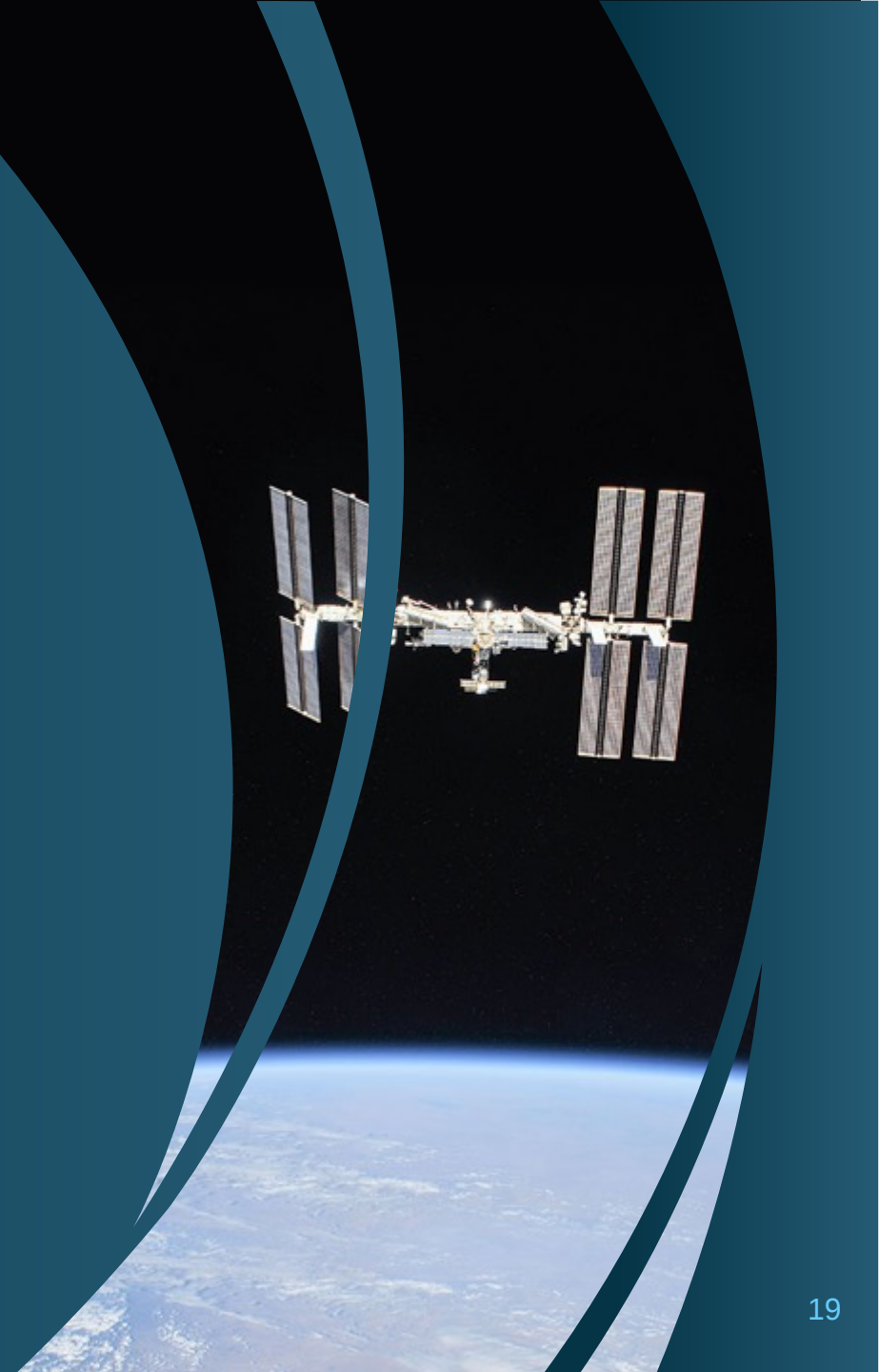


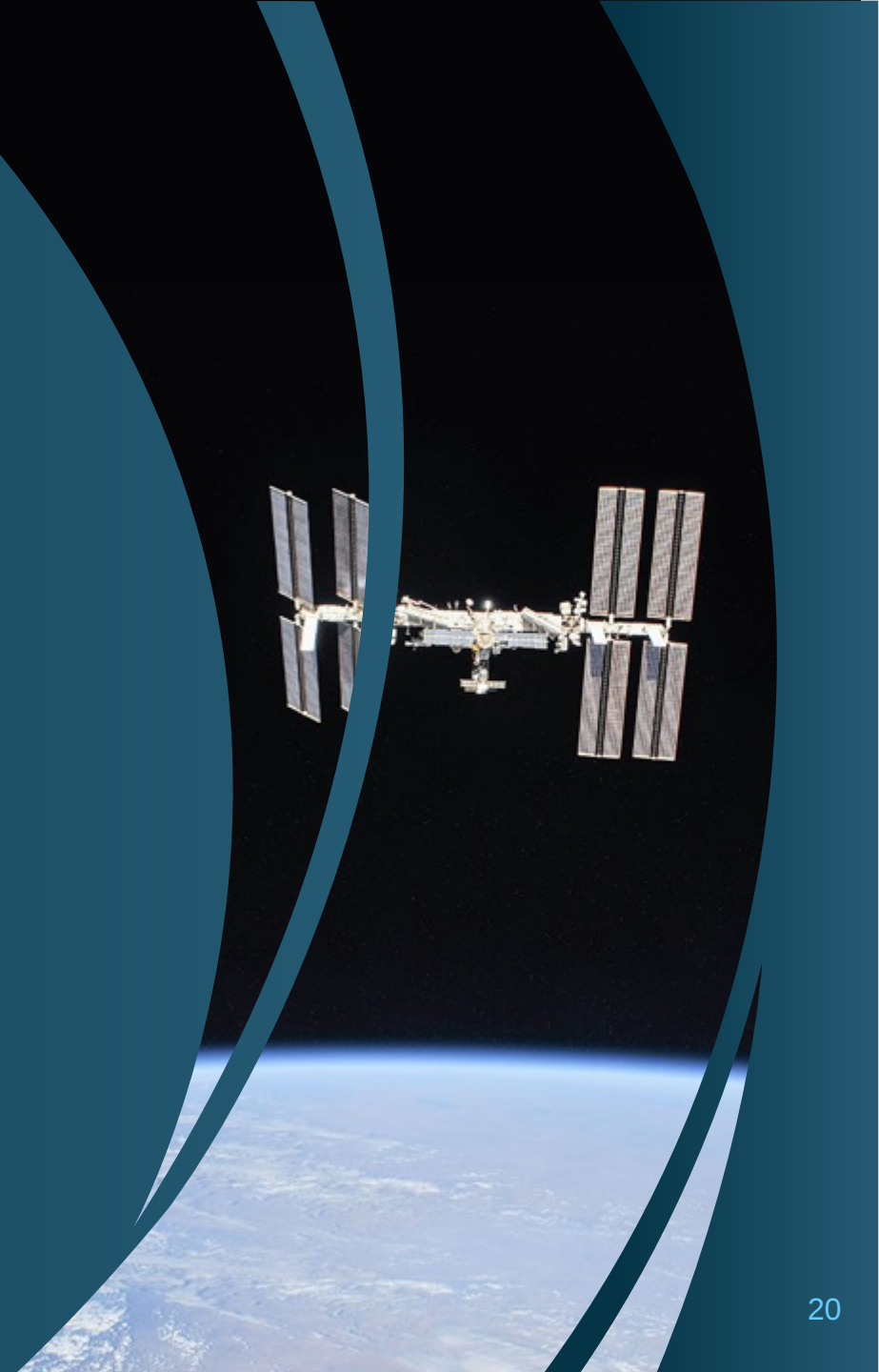
Note: These values are based on an average metabolic rate of 136.7 W/person (11,200 BTU/person/day) and a respiration quotient of 0.87. The values will be higher when activity levels are greater and for larger than average people. The respiration quotient is the molar ratio of CO₂ generated to O₂ consumed.



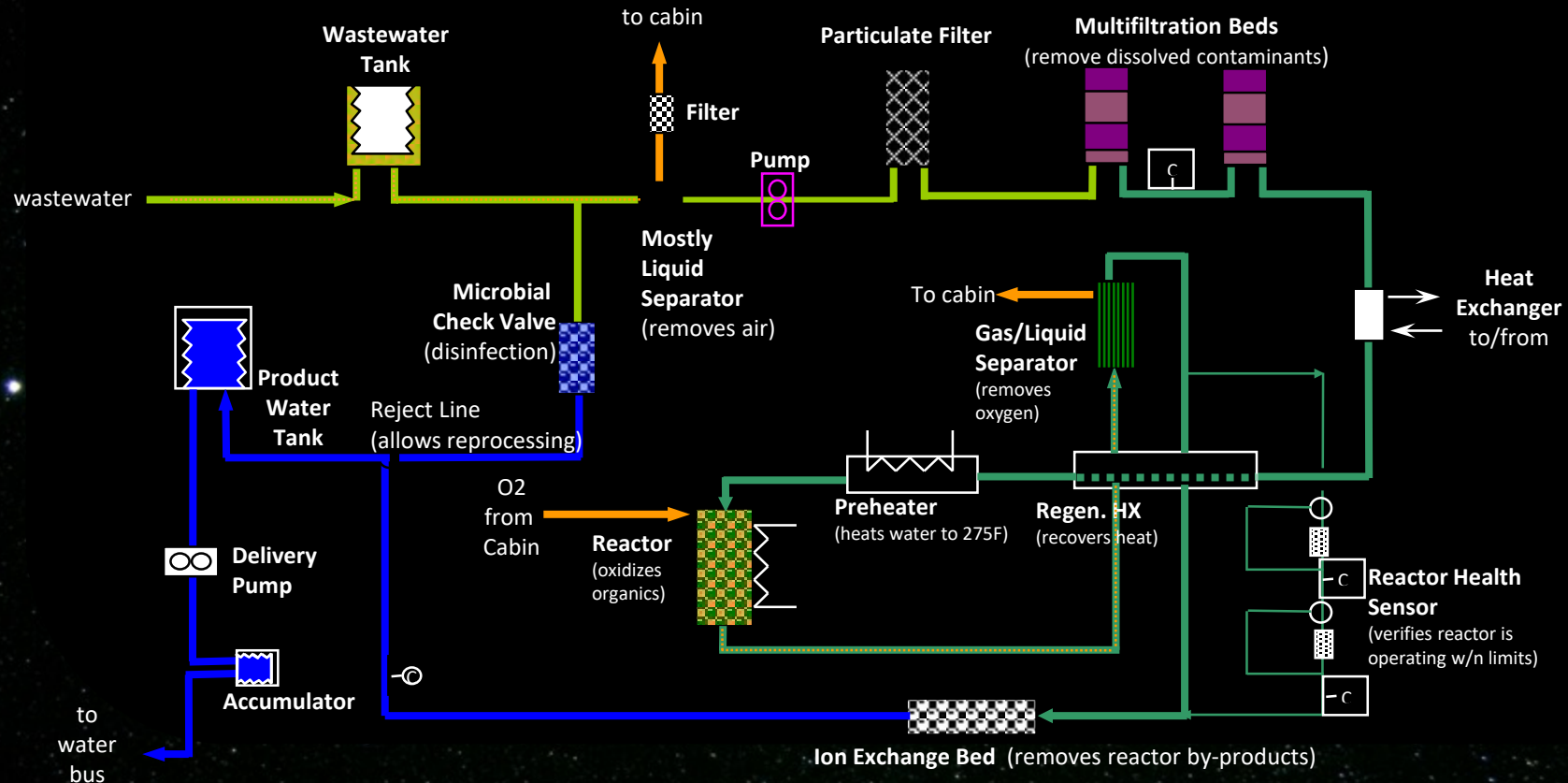




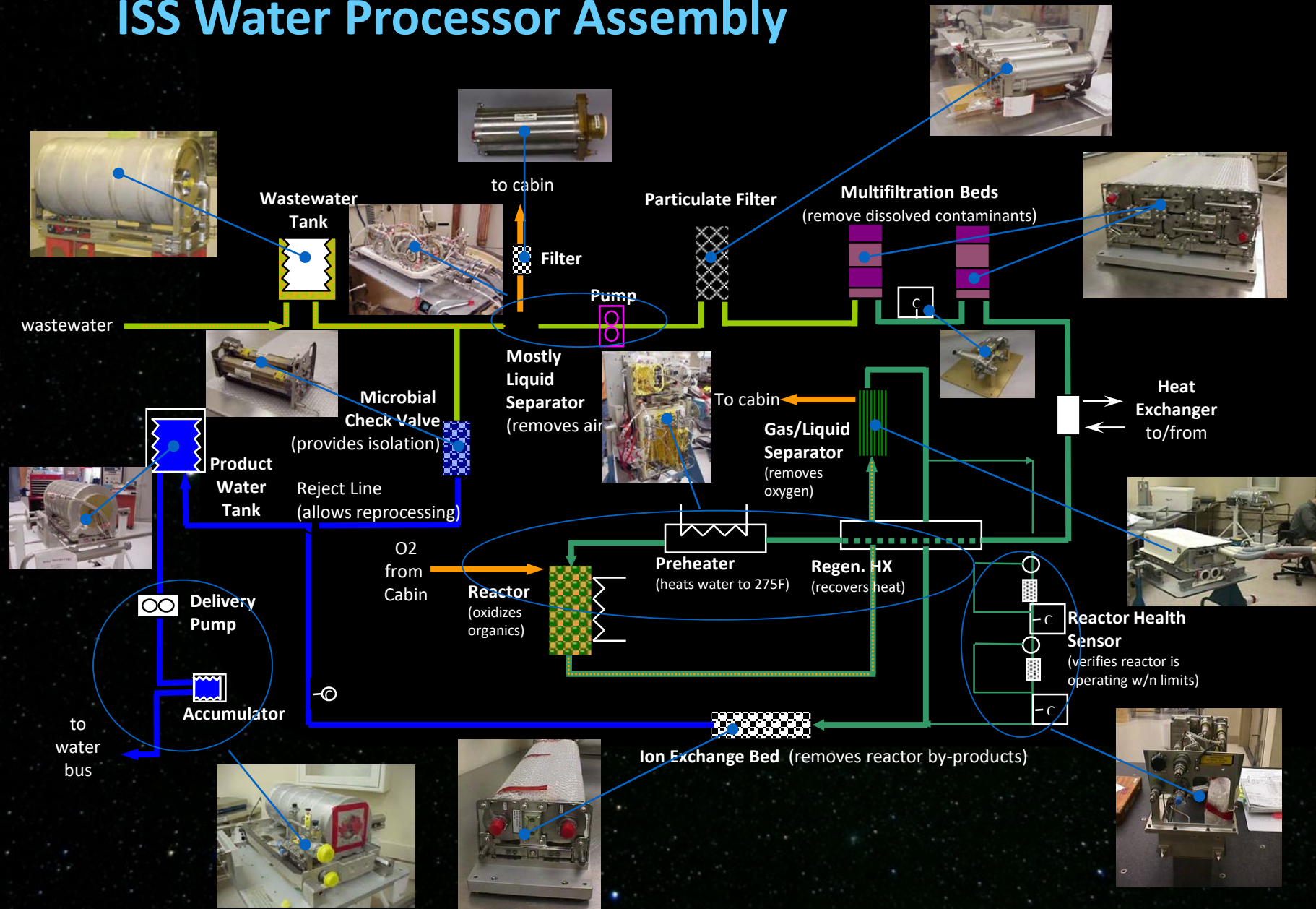


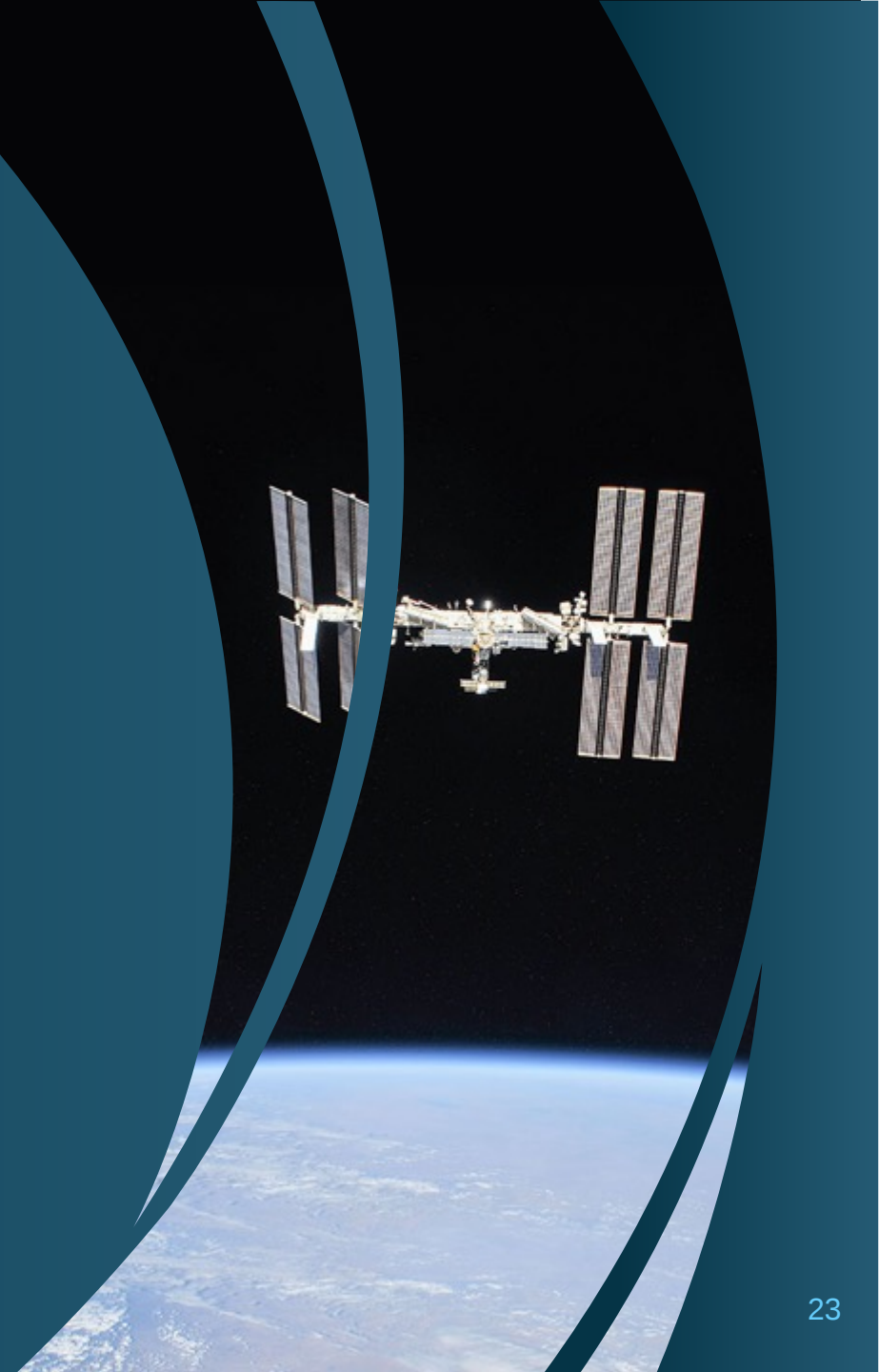
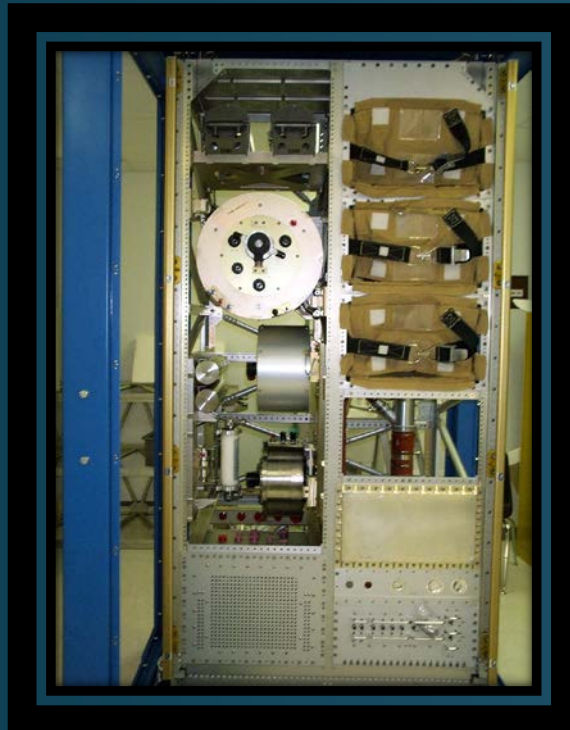
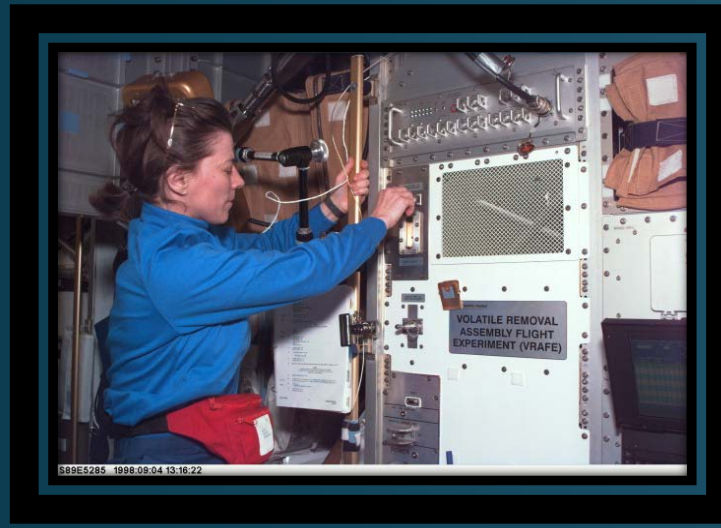


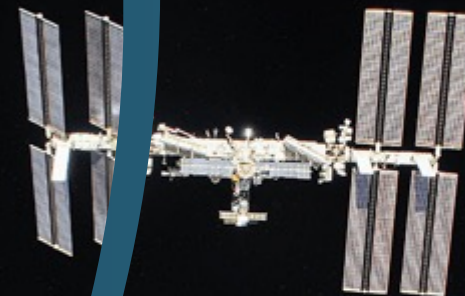
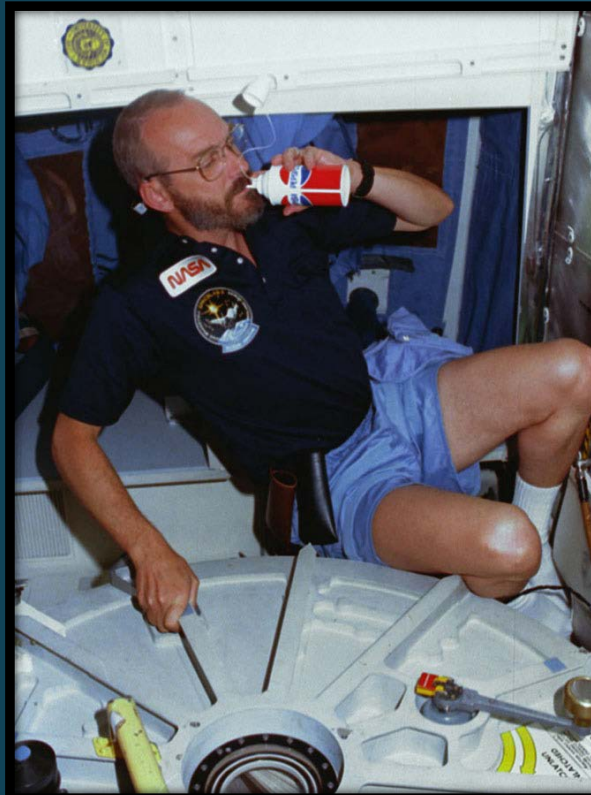
ISS Water Processor Assembly



ISS Water Processor Assembly







EVOLVING ECLSS FOR EXPLORATION

National Aeronautics and
Space Administration

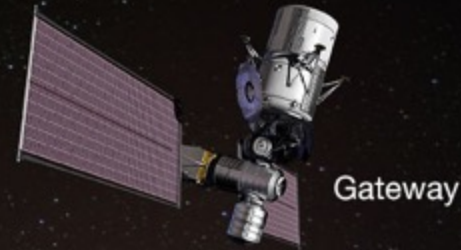


Evolution of ISS ECLSS
into Exploration ECLSS

Continue ECLSS Testbed in
Low-Earth Orbit (LEO)

Infuse Exploration
ECLSS as Applicable

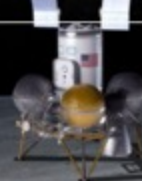
Infuse Exploration ECLSS
into Mars Transport and Surface



Surface Systems Ground Test



Lunar Surface ECLSS: Excursion – Short Duration | Base – Regenerative



Mars Surface Regenerative ECLSS



CHALLENGES OF EVOLVING ECLSS FOR EXPLORATION

National Aeronautics and
Space Administration



Evolution of ISS ECLSS into Exploration ECLSS

Challenges:

- Add new capabilities
- Improve reliability of existing capabilities



International Space Station (ISS)

Continue ECLSS Testbed in Low-Earth Orbit (LEO)

Challenges:

- Enable commercial platforms
- Continue long-term reliability testing & test new tech in ug

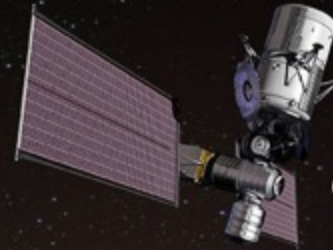


Notional Commercial Platform

Infuse Exploration ECLSS as Applicable

Challenges:

- Uncrewed operations/dormancy
- Autonomy
- Reduced logistics supply/disposal
- Dust



Gateway

Infuse Exploration ECLSS into Mars Transport and Surface

Challenges:

- Robustness of system for mission duration
- Additional ECLSS loop closure

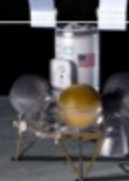


Deep Space Transport (DST)

Surface Systems Ground Test



Lunar Surface ECLSS: Excursion – Short Duration | Base – Regenerative



Mars Surface Regenerative ECLSS

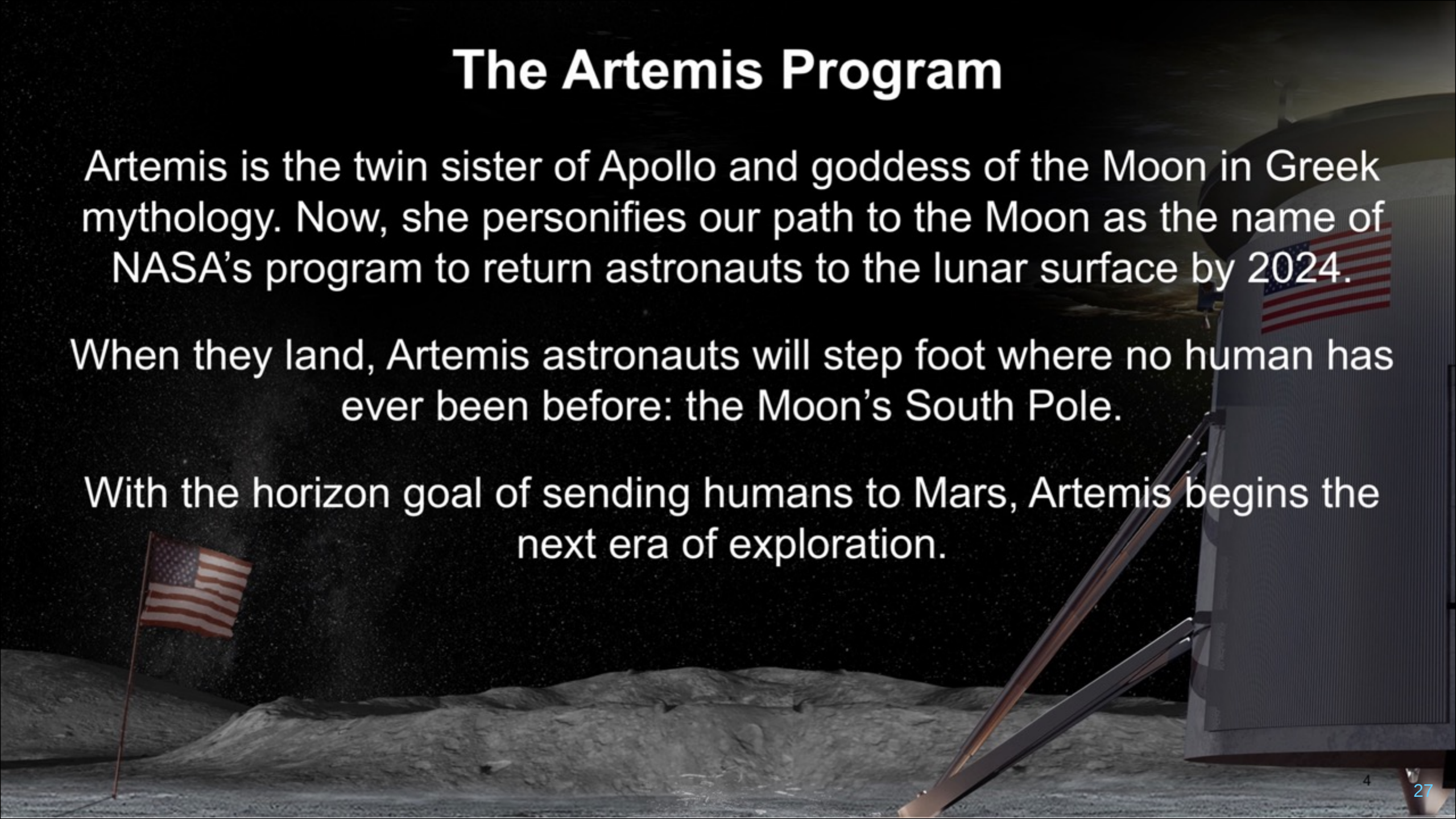


The Artemis Program

Artemis is the twin sister of Apollo and goddess of the Moon in Greek mythology. Now, she personifies our path to the Moon as the name of NASA's program to return astronauts to the lunar surface by 2024.

When they land, Artemis astronauts will step foot where no human has ever been before: the Moon's South Pole.

With the horizon goal of sending humans to Mars, Artemis begins the next era of exploration.



The Power of SLS and Orion



ORION

The only spacecraft capable of carrying and sustaining crew on missions to deep space, providing emergency abort capability, and safe re-entry from lunar return velocities

SLS

The only rocket with the power and capability required to carry astronauts to deep space onboard the Orion spacecraft

NATIONAL CAPABILITY

The SLS and Orion programs (including Exploration Ground Support at Kennedy Space Center) leverages over 3,800 suppliers and over 60,000 workers across all 50 states

It's going
to take all
of us!



National Aeronautics and
Space Administration



Questions?...

EXPLORE MOON_{to}MARS