Water Recycling in Space & technologies that have been adapted to Earth

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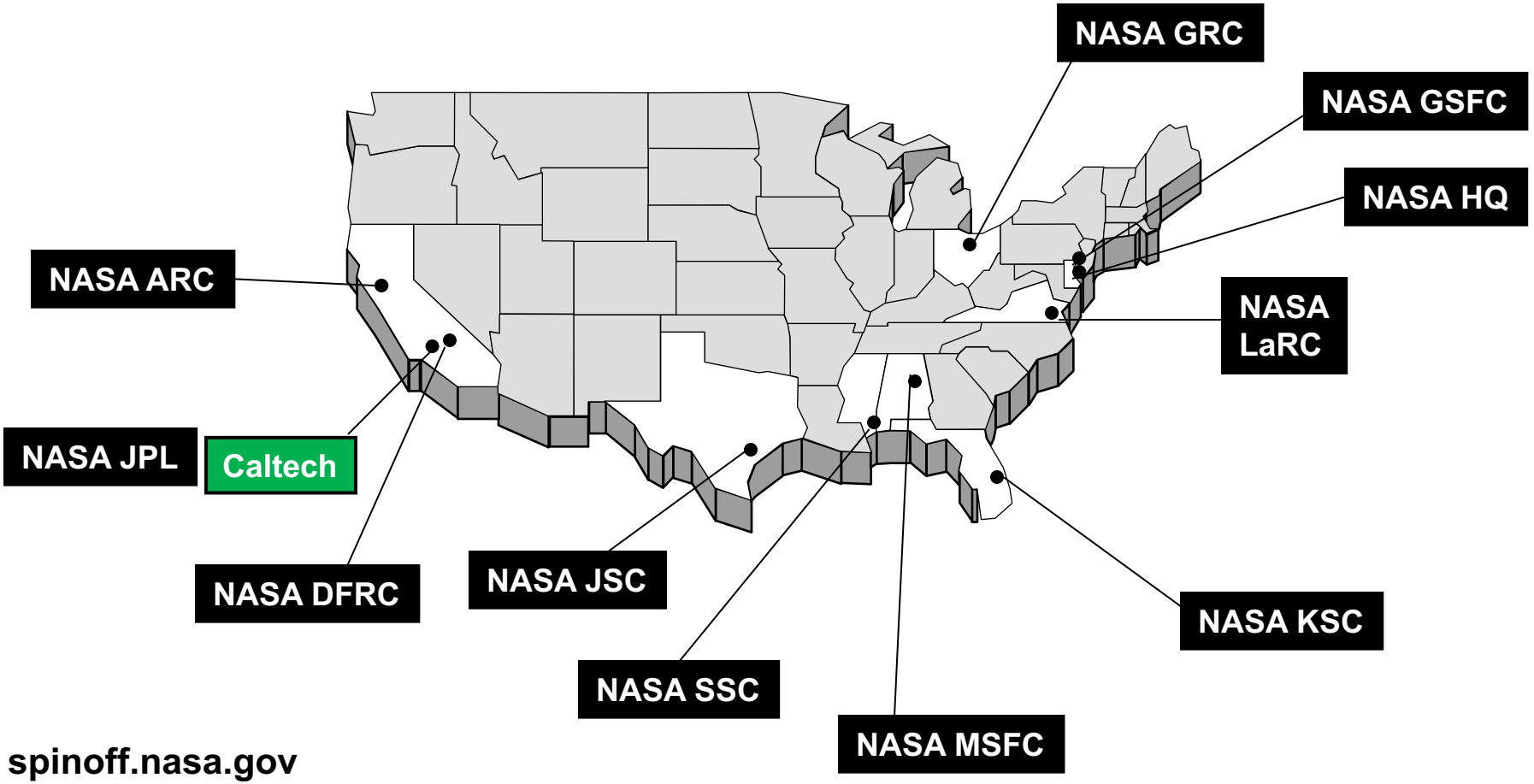
NASA FACILITIES



spinoff.nasa.gov

National Aeronautics and Space Administration

Ames

Discovery Innovations Solutions

NASA Ames Research Center (ARC)

- One of ten NASA field centers.
- Located in the heart of California's Silicon Valley (GOOGLE, APPLE, STANFORD UNIVERSITY…).
- **Established:** December 20, 1939, as part of the National Advisory Committee for Aeronautics (NACA), in 1958 absorbed into the National Aeronautics and Space Administration (NASA).

National Aeronautics and Space Administration

Ames

Discovery Innovations Solutions

National Aeronautics and Space Administration

Ames

Discovery Innovations Solutions

ADVANCED LIFE SUPPORT

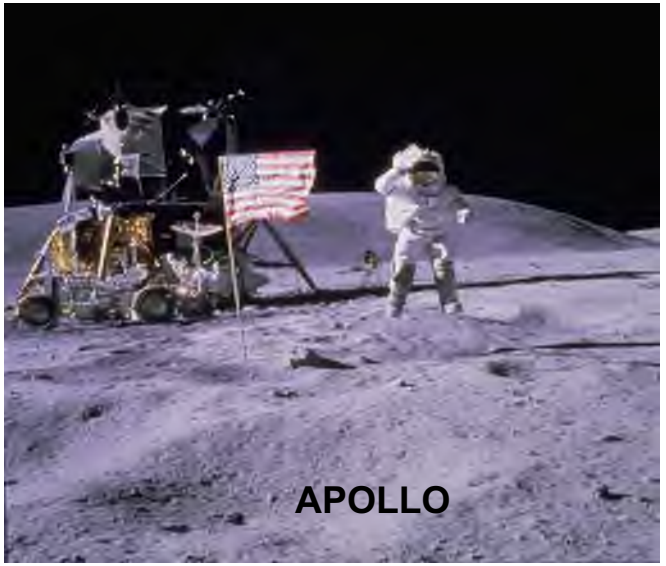
OBJECTIVES:

- Keep astronaut alive
- Provide habitable environment
- Reduce cost

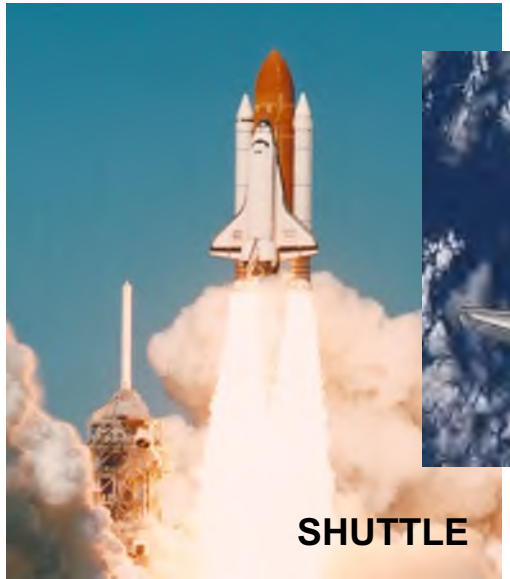
"OPEN LOOP SYSTEMS"

MERCURY


GEMINI


APOLLO


SKYLAB


SHUTTLE

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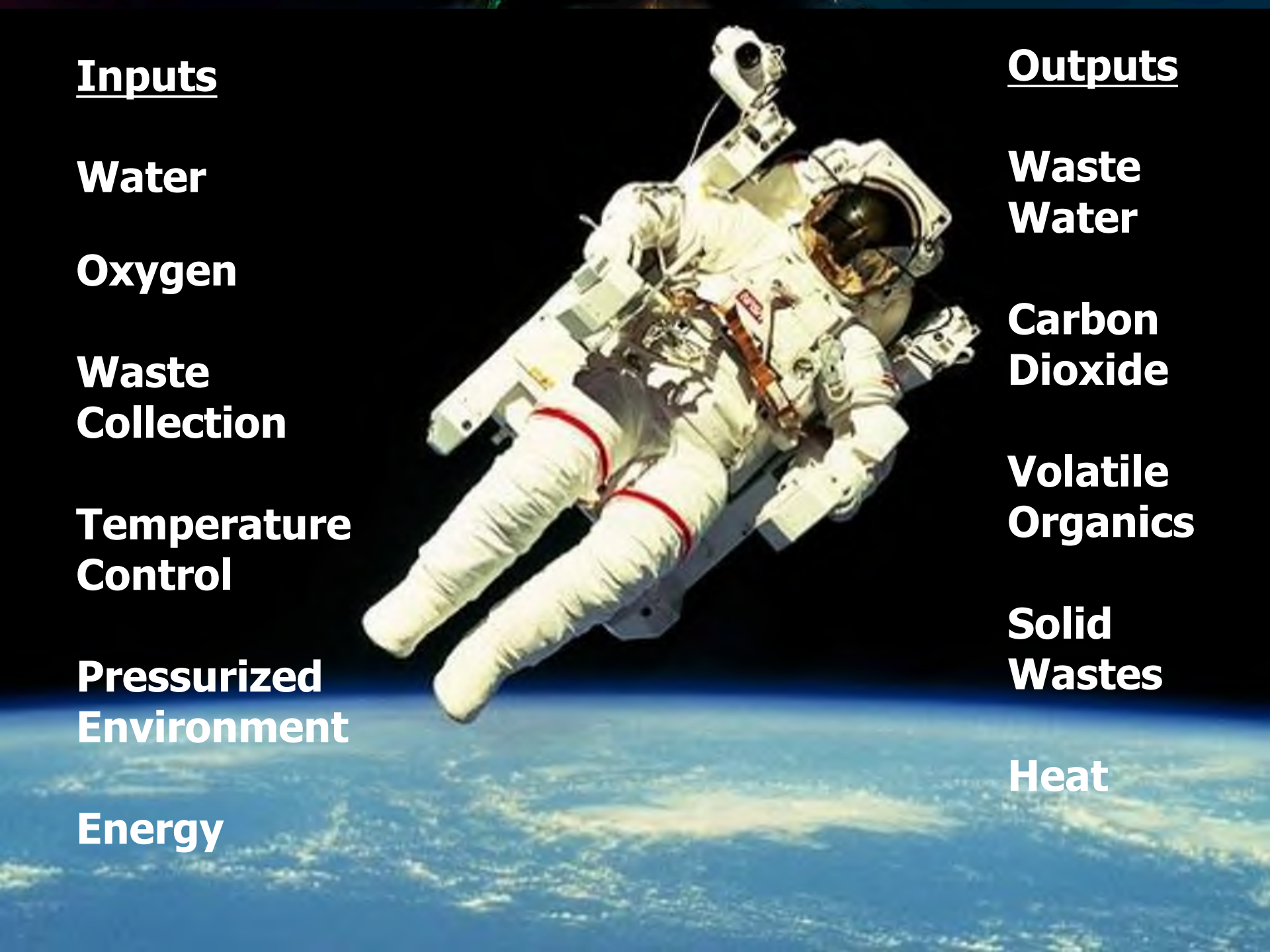
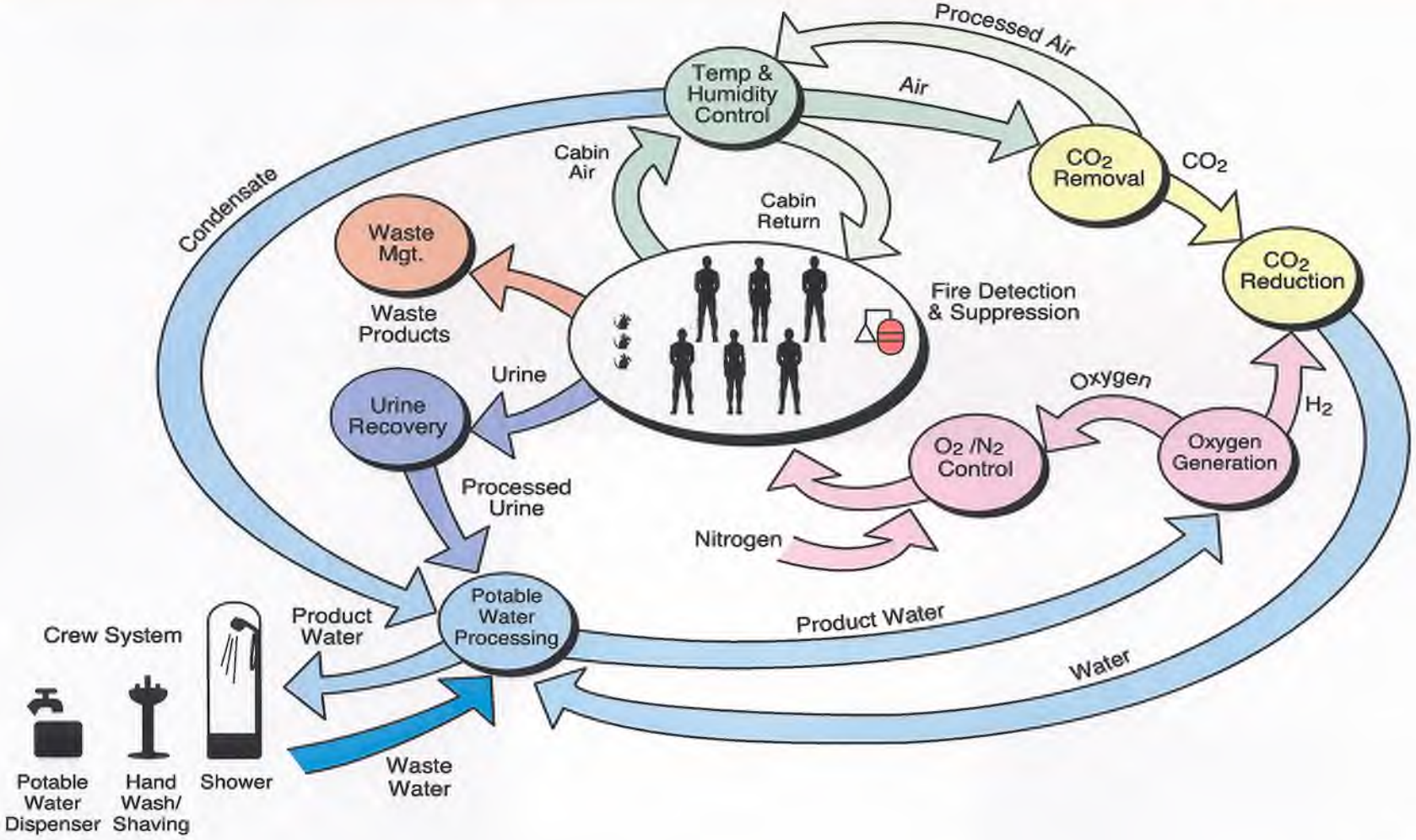
INTERNATIONAL SPACE STATION (ISS)
"CLOSED LOOP SYSTEM"


Inputs
Water
Oxygen
Waste Collection
Temperature Control
Pressurized Environment
Energy
Outputs
Waste Water
Carbon Dioxide
Volatile Organics
Solid Wastes
Heat

Space Station Regenerative ECLSS Flow Diagram (Baseline and Scarring)



MSFC/5-23920

ISS US Water Processing Assembly

- **Urine and condensate are recycled to drinking water.**
- **Wastewater is recycled using distillation, adsorption, and oxidation.**

ISS US Water Processing Assembly

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- Wastewater is recycled using distillation, adsorption, and oxidation.

LESSONS LEARNED FROM OPERATING THE WPA

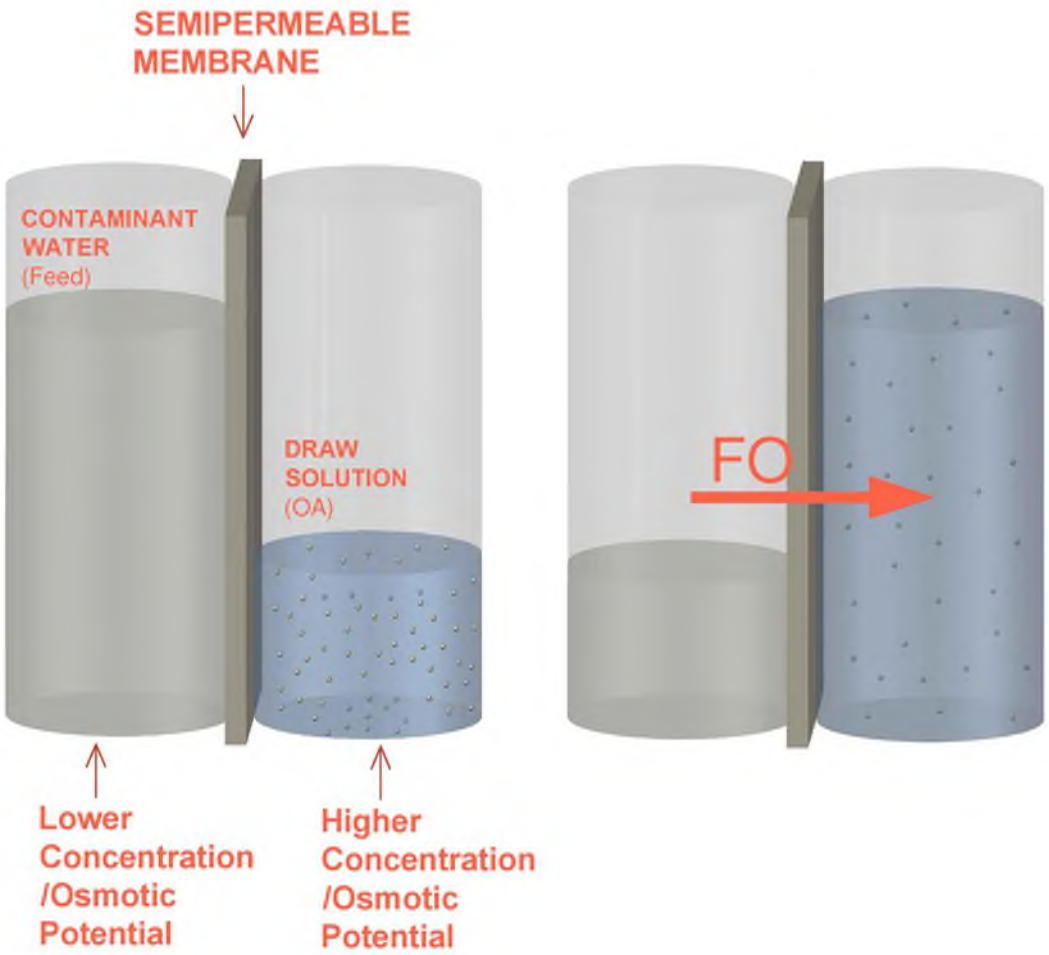


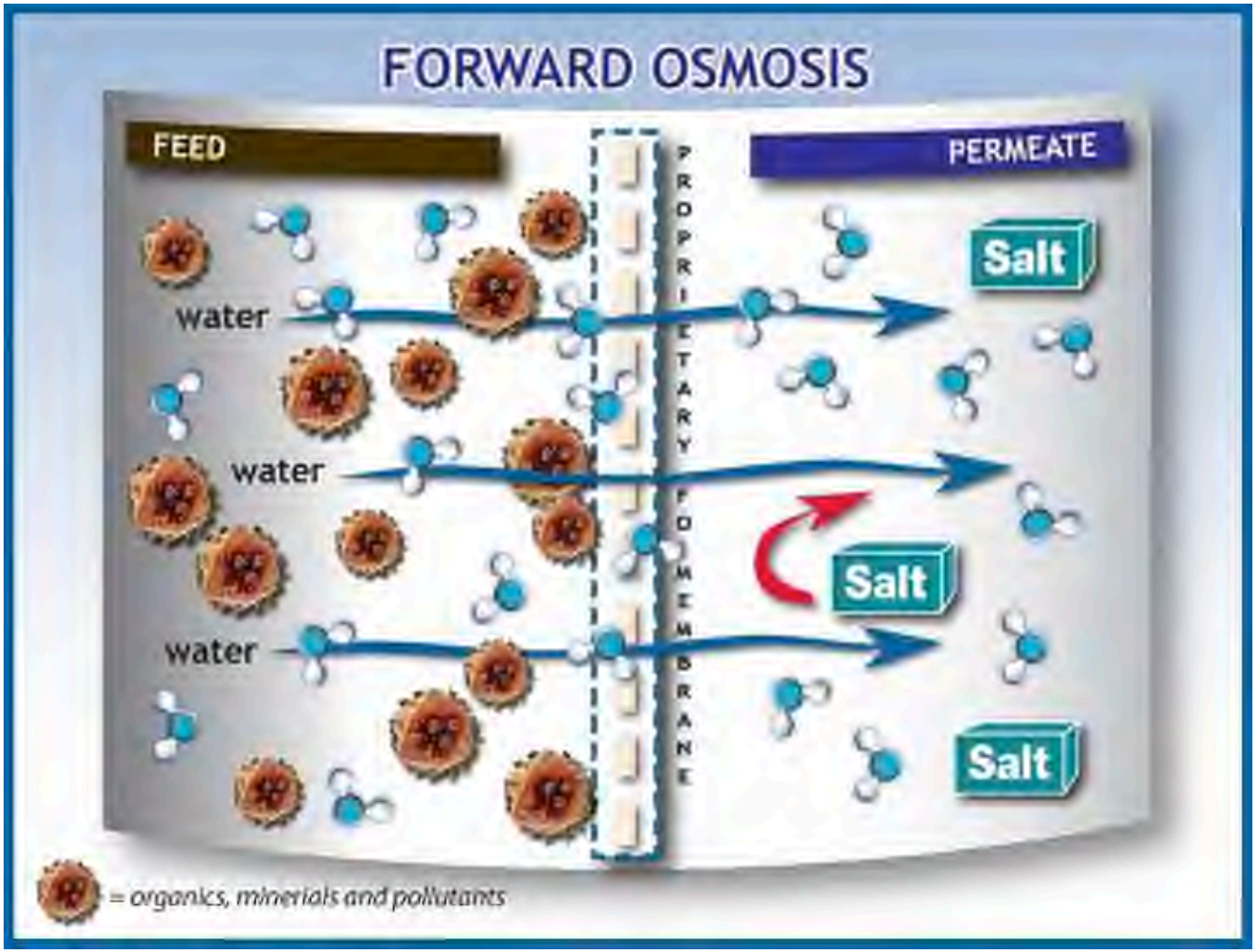

- Formation of calcium scale determines maximum recovery ratio.
- Trace contaminates build up.
- Maintenance requirements are high.
- Reliability matters. Especially for future long duration missions.

FORWARD OSMOSIS RESEARCH AND DEVELOPMENT

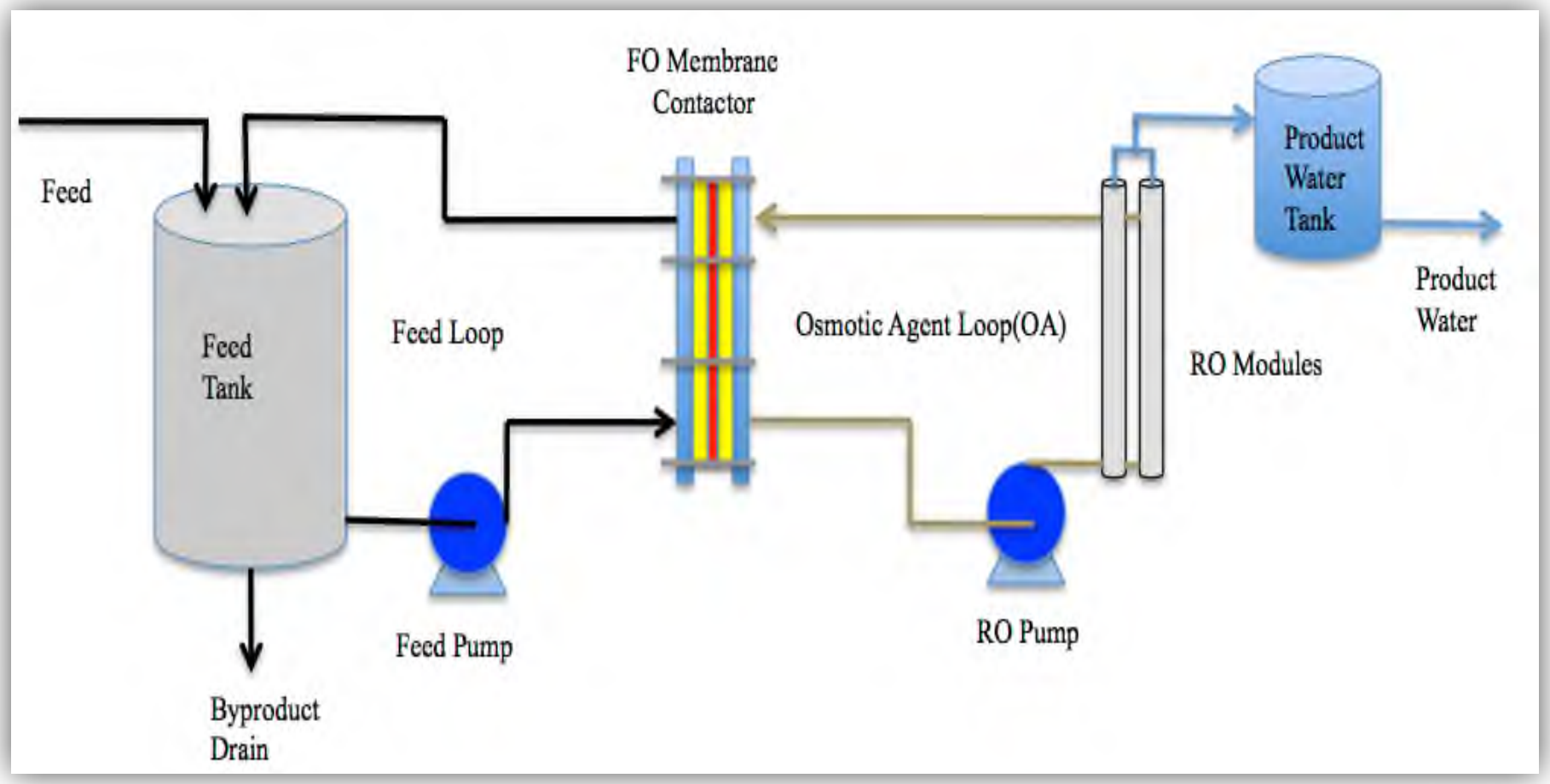
FO selected by NASA as part of the baseline system for the Next Generation Life Support Mars base water recycling system.

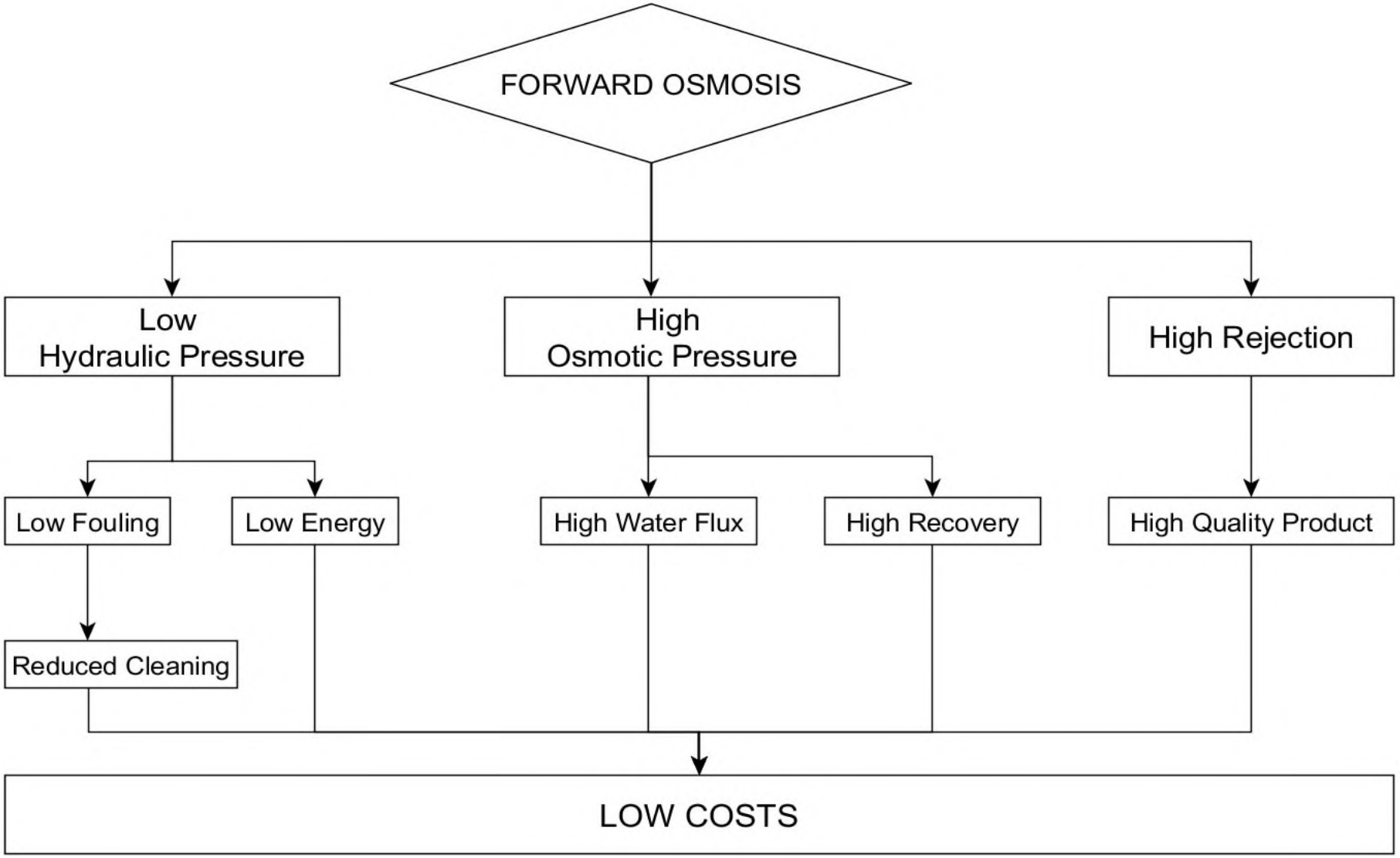
OSMOSIS DIRECTA/FORWARD OSMOSIS (FO)




FORWARD OSMOSIS
FEED
PERMEATE
PROPRIETARY FO MEMBRANE
water
water
water
Salt
Salt
Salt
= organics, minerals and pollutants

FO PRETREATMENT




FORWARD OSMOSIS
Low Hydraulic Pressure
High Osmotic Pressure
High Rejection
Low Fouling
Low Energy
High Water Flux
High Recovery
High Quality Product
Reduced Cleaning
LOW COSTS

WATER RECYCLING TECHNOLOGIES

DIRECT OSMOTIC CONCENTRATION SYSTEM (DOC)

- First NASA technology based on FO.
- Urine and humidity condensate into potable water.
- The product of **FO**, **RO** are post treated using an **Aqueous Phase Catalytic Oxidizer (APCO)**.

LIGHTWEIGHT CONTINGENCY WATER RECYCLING SYSTEM (LCWR)

- Individual (personal) urine recycling system.
- Designed for EVA and **emergency contingency applications.**
- Uses activated carbon treatment followed by forward osmosis (FO).