EVA ROADMAP: NEW SPACE SUIT FOR THE 21st CENTURY

Robert Yowell
NASA Johnson Space Center
EVA Project Office

Regenerable CO₂ Removal
• Swing Beds (Currently not practical in Mars atmosphere)
• Liquid and solid amines - absorption of CO₂
• Biologic process - carbonic anhydrase
• Laser ionization - requires high power laser
• Cryo freeze out of CO₂ - would be practical with use of cryogenic O₂ PLSS

PLSS Oxygen Systems
• Use of Cryogenic oxygen produced from in-situ manufacture
• Breathable Oxygen produced “real-time” from martian atmosphere as astronaut walks
• Stored gaseous oxygen (non-regenerable, finite supply)

EVA Power Supply
• Batteries - must reduce weight, increase power, reduce recharge time (current shuttle EMU battery requires 22 hours of recharge for 8 hour EVA)
• Fuel Cells - fully regenerative, recharge quicker than batteries

PLSS Thermal Control Systems
• Radiator cooling system which uses low quality water (current EMU sublimator uses 8 lbs of high quality purified water for each PLSS - sublimator is designed to work in a vacuum environment - not on Mars surface)
• Heat exchangers/Heat pumps

Systems Engineering and Architecture
• PLSS packaging/modularity - component miniaturization
• Ease of maintenance and replacement of components
• Commonality of component parts with life support systems in habitat, pressurized rover, etc.

Space Suit Systems
• Stronger, lighter weight suit materials
• Highly mobile suit with flexible joints
• Power assisted joints, gloves
Human Considerations
- Improved biomedical sensors and monitoring
- Improved astronaut comfort in suit (thermal, muscular, etc.)
- In suit food/drink
- Waste management

Displays and Controls
- Smaller suit sensors
- Improved suit/PLSS caution and warning (failure identification, rapid reconfiguration)
- Robust two-way voice and video communications. Improved display technology (Heads Up/Retinal)
- Voice recognition command systems

Robotics Interface
- Small, self-propelled EVA caddies (provide back-up PLSS and/or PLSS recharge capability)
- Unpressurized and pressurized rovers
- Telerobotic command and control interface

**EVA Research and Technology Roadmap**

- PLSS® Regenerable CO₂ Removal Systems
  - Reduce - Size, Weight, Volume
  - Increase - Life Cycle, Reliability
  - Eliminate - Consumable Requirements

- PLSS Oxygen Systems
  - Provide the capability for EVA astronaut to utilize cryogenic O₂ from PLSS or other sources

- PLSS Power Supply Systems
  - Reduce - Size, Weight, Volume, Recharge Time
  - Increase - Endurance, Available Power

- PLSS Thermal Control Systems
  - Provide adequate heating and cooling for all PLSS systems with minimal consumables

- Systems Engineering and Architecture
  - Reduce - Size, Weight, and Complexity
  - Increase - Reliability and Safety
  - Full capability of maintenance and repair on Mars surface ofSuitable PLSS

- Lightweight, Highly Mobile Suit Systems
  - Reduce suit weight
  - Optimize mobility in legs, arms, shoulders, and waist
  - Improve glove dexterity

- Human Considerations
  - Physiologic and Psychologic factors for the EVA astronaut

- Advanced Suit Displays and Controls
  - Develop small lightweight screen mounted or ovisor integrated display system for two-way multi-media communications

- Human-Robotic Interface Systems
  - Provide robotic assistance to EVA crewmember on surface.
  - Ensure EVA crewmember’s endurance

---

**Implementation Strategy:**
The Roadmap elements listed here do not present any intended prioritization. These elements consist of those necessary to complete a 500-day Mars surface stay. Specific technologies will be pursued based on lead time, industry capabilities, and funding availability.