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**ABSTRACT: Water Electrolysis for In-Situ Resource Utilization (ISRU)**

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Sending humans to Mars for any significant amount of time will require capabilities and technologies that enable Earth independence. To move towards this independence, the resources found on Mars must be utilized to produce the items needed to sustain humans away from Earth. To accomplish this task, NASA is studying In Situ Resource Utilization (ISRU) systems and techniques to make use of the atmospheric carbon dioxide and the water found on Mars. Among other things, these substances can be harvested and processed to make oxygen and methane. Oxygen is essential, not only for sustaining the lives of the crew on Mars, but also as the oxidizer for an oxygen-methane propulsion system that could be utilized on a Mars ascent vehicle. Given the presence of water on Mars, the electrolysis of water is a common technique to produce the desired oxygen. Towards this goal, NASA designed and developed a Proton Exchange Membrane (PEM) water electrolysis system, which was originally slated to produce oxygen for propulsion and fuel cell use in the Mars Atmosphere and Regolith COllector/PrOcessor for Lander Operations (MARCO POLO) project. As part of the Human Exploration Spacecraft Testbed for Integration and Advancement (HESTIA) project, this same electrolysis system, originally targeted at enabling in situ propulsion and power, operated in a life-support scenario. During HESTIA testing at Johnson Space Center, the electrolysis system supplied oxygen to a chamber simulating a habitat housing four crewmembers. Inside the chamber, oxygen was removed from the atmosphere to simulate consumption by the crew, and the electrolysis system's oxygen was added to replenish it. The electrolysis system operated nominally throughout the duration of the HESTIA test campaign, and the oxygen levels in the life support chamber were maintained at the desired levels.