Gateway Element and Payload Materials Outgassing Analyses: HALO, HERMES, and ERSA

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Gateway was intended to be humanity's first space station around the Moon, but its development has been paused as the National Aeronautics and Space Administration (NASA) shifts focus to achieving the United States' National Space Policy goals. Instead of an orbiting lunar outpost, NASA will now pursue the development of a lunar surface base to support a sustained human presence on the Moon. Before the program's pause, Gateway's Induced Environments team worked to ensure payloads and elements (i.e., modules) complied with induced environment requirements. Methods developed and insights gained from this work will have applicability to NASA's Moon Base and the potential repurposing of Gateway elements and payloads, as well as to induced environments modeling for future space stations.

The Gateway program's *induced environment* included molecular contamination, electric thruster plume sputter and redeposition, and lunar dust transfer from the Human Landing System (HLS). Primary sources of external molecular contamination included materials outgassing, chemical thruster plume contamination, and vacuum venting. The focus of this paper will be on element- and payload-level materials outgassing analyses performed for Gateway Configuration 1, extending the previously-developed framework for Gateway system-level external molecular contamination modeling. Gateway Configuration 1 consisted of the Power and Propulsion Element (PPE) and the Habitation and Logistics Outpost (HALO). It also included payloads like the European Radiation Sensor Array (ERSA) attached to PPE and the Heliophysics Environmental and Radiation Measurement Experiment Suite (HERMES) attached to HALO.

The element- and payload-level analyses to be introduced in this paper for HALO, HERMES, and ERSA enabled high-fidelity descriptions of Gateway's external molecular contamination environment. Approaches to geometric modeling, meshing, outgassing rate assignment, molecular transport modeling, and analysis methodology will be presented. Element and payload contaminant deposition onto sensitive Gateway receiver surfaces will be summarized and results compared to induced environment requirements. While these results incorporate refinements made over the course of the program, they were not intended to be final. Therefore, modeling assumptions and inputs, potential improvements, and lessons-learned will be documented to inform future work on Moon Base, repurposed elements and payloads, and other space stations.