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BLUE GHOST MISSION 1: AUTONOMOUS LUNAR OPERATIONS AND SCIENTIFIC PAYLOAD DEPLOYMENT FOR FUTURE EXPLORATION

Abstract

Blue Ghost Mission 1 (TO 19D), launched on January 15, 2025, exemplified autonomous lunar orbital maneuvers and scientific payload deployment, providing irreplaceable experience for upcoming Artemis and deep-space missions. The lunar lander, carrying ten NASA payloads, including the Lunar GNSS Receiver Experiment (LuGRE), is home to state-of-the-art power management, thermal control, and high-bandwidth communications.

Following translunar injection on February 8, 2025, the mission carried out a series of precise trajectory correction maneuvers, lunar orbit insertion, and follow-up orbit lowering, achieving 100 km low-lunar orbit on February 24, 2025. These maneuvers, achieved with a 16-second burn on February 21, 2025, attest to the lander's advanced autonomous navigation system. The thermal control system, by means of heat pipes, radiators, and active heaters, provided operational integrity in these phases. The communication system, with its 6 Mbit/s downlink and 0.2 Kbit/s uplink capacity, facilitated effective data communication.

Scientific operations commenced on January 16, 2025, with LuGRE experiments having received GNSS signals in lunar orbit, verifying the feasibility of lunar-based positioning systems. This success is crucial to lunar navigation in the future and potential Mars missions. The mission also conducted dual-fuel priming tests, which contributed to lunar propellant management technology. On March 2, 2025, the mission had successfully transmitted the first high-resolution image from the lunar surface, contributing to the 27 GB of scientific data that had been acquired by February 27, 2025.

Blue Ghost Mission 1 paves the way for accurate lunar landing, independent orbit operations, and high-quality scientific data acquisition. The effective deployment and integration of diverse payloads, including LuGRE, demonstrate the viability of extended lunar operations. These competencies are essential in establishing a continued human presence on the Moon and advancing to Mars and beyond, a colossal step in the evolution of deep-space exploration.