Resource Prospector Propulsion System Cold Flow Testing

ABSTRACT

Resource Prospector (RP) is a NASA mission being led by NASA Ames Research Center with current plans to deliver a scientific payload package aboard a rover to the lunar surface. As part of an early risk reduction activity, Marshall Space Flight Center (MSFC) and Johnson Space Flight Center (JSC) have jointly developed a government-version concept of a lunar lander for the mission. The spacecraft consists of two parts, the lander and the rover which carries the scientific instruments. The lander holds the rover during launch, cruise, and landing on the surface. Following terminal descent and landing the lander portion of the spacecraft become dormant after the rover embarks on the science mission.

The lander will be equipped with a propulsion system for lunar descent and landing, as well as trajectory correction and attitude control maneuvers during transit to the moon. Hypergolic propellants monomethyl hydrazine and nitrogen tetroxide will be used to fuel sixteen 70-lbf descent thrusters and twelve 5-lbf attitude control thrusters. A total of four metal-diaphragm tanks, two per propellant, will be used along with a high-pressure composite-overwrapped pressure vessel for the helium pressurant gas. Many of the major propulsion system components are heritage missile hardware obtained by NASA from the Air Force.

In parallel with the flight system design activities, a simulated propulsion system based on flight drawings was built for conducting a series of water flow tests to characterize the transient fluid flow of the propulsion system feed lines and to verify the critical operation modes such as system priming, waterhammer, and crucial mission duty cycles. The primary objective of the cold flow testing was to simulate the RP propulsion system fluid flow operation through water flow testing and to obtain data for anchoring analytical models. The models will be used to predict the transient and steady state flow behaviors in the actual flight operations. All design and build efforts, including the analytical modeling, have been performed. The cold flow testing of the propulsion system was set up and conducted at a NASA MSFC test facility.

All testing was completed in the summer of 2014, and this paper documents the results of that testing and the associated fluid system modeling efforts.