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STUDENT DESIGNED PROPULSION SYSTEM FOR A REUSABLE FLIGHT VEHICLE

Abstract

This paper describes developing the feed system and ground support equipment (GSE) for a reusable flight vehicle. The vehicle, with a mass of one metric ton, will be launched to an altitude of 6 km with two 10-kN liquid rocket engines. The flight feed system and GSE are developed at the Liquid Propulsion Laboratory at the University of Southern California. This project is in collaboration with Kyushu Institute of Technology, in Japan. Kyushu Institute of Technology is making the launch vehicle and propellant tanks. The flight vehicle is a part of a series with increasing capabilities, with the ultimate goal of reaching space.

The feed system must be capable of supplying the engine (also developed at the Liquid Propulsion Laboratory) with propellants for a 25-s burn time. The vehicle descends with parachutes and lands with airbags, which will allow the vehicle to be reused. Therefore, the flight feed system must be robust enough to withstand the forces imposed throughout the launch. The vehicle is a helium pressure-fed system with kerosene and liquid oxygen as propellants. A control system with electronics was designed and manufactured to acquire data from sensors and actuate valves to fill the propellant tanks and provide the two engines with propellants while ensuring safety.

The tanks in the vehicle are helium, kerosene, and liquid oxygen. Each will be filled using the GSE. The helium tank will be filled by pressure equalization using high-pressure cylinders. The kerosene tank will be filled using a fuel pump. The liquid oxygen tank will be filled using boil-off pressure from a liquid oxygen dewar. The GSE will interface to the vehicle with quick disconnects for kerosene and liquid oxygen; the helium line will be connected with a tube fitting.

The flight feed system is designed to interface with the GSE for filling process and to the engine to supply the propellants during launch. The helium line will run from the helium tank to the kerosene tank, liquid oxygen tank, and to the engine for purging the system. The feed system must supply each engine with a required mass flow rate of 1.65-kg/s and 2.48-kg/s for kerosene and liquid oxygen, respectively, throughout the 25-s burn time. After landing, the system will be purged with helium to ensure safety before recovery.