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MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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A SYSTEMATIC MICROGRAVITY TESTING APPROACH TO ADVANCE THE TECHNOLOGY READINESS LEVEL OF ON-ORBIT PROPELLANT DEPOTS

Abstract

NASA's current framework depicts the design and development of a Multi-Purpose Crew Vehicle to conduct regular in-space operations beyond Low Earth Orbit (LEO). However, such in-space transportation missions possess requirements beyond the lift capability of medium-lift Commercial Launch Vehicles (CLVs). To overcome this, NASA's current Space Launch System (SLS) outlines the development of advanced Heavy Lift Launch Vehicles (HLLVs) that will evolve to produce lift capabilities upwards of 100 MT. Not only will the production of HLLVs require large amounts of man hours and capital but the structural development of these vehicles will span the next decade. For these reasons, the use of current CLVs and the implementation of on-orbit propellant depots have shifted into focus and have become a viable and timely alternative to the SLS. Currently, the United Launch Alliance is developing an on-orbit propellant depot that is derived from the Centaur upper stage of the Atlas launch vehicle. Once on-orbit, the depot will be spun stabilized about its minor (short) axis while several propellant transfers, or Fluid Management (FM) processes, take place. To advance the Technology Readiness Level (TRL) for this technology and bring the existence of on-orbit propellant depots into a near term reality, the planned theoretical FM processes must be validated and the consequences these processes pose on the operational stability of the space system must be understood. In order to accomplish this, a systematic line of experiments have begun that will bring this technology from a university laboratory to the internal confines of the International Space Station (ISS). During June of 2011, ground testing on a 1:37 scale model of the Centaur derived system was carried out at Embry-Riddle Aeronautical University. The completion of this testing validated the planned on-orbit FM processes and provided performance predictions for parabolic flight testing. The completion of parabolic flight testing in July of 2011 paved the way for sub-orbital testing that will take place in the summer of 2013 and ISS testing that will take place in the year that follows. This systematic microgravity testing approach will be broken down and explained in detail. The results of the ground testing and parabolic flight testing will be discussed to provide a basis of understanding as to how this progressive microgravity testing approach is beneficial to the advancement of this technology.