Heavy Lift Launch Capability with a New Hydrocarbon Engine (NHE)

Abstract

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The Advanced Concepts Office (ACO) at NASA Marshall Space Flight Center has analyzed over 2000 Ares V and other heavy lift concepts in the last 3 years. These concepts were analyzed for Lunar Exploration Missions, heavy lift capability to Low Earth Orbit (LEO) as well as exploratory missions to other near earth objects in our solar system. With the pending retirement of the Shuttle fleet, our nation will be without a civil heavy lift launch capability, so the future development of a new heavy lift capability is imperative for the exploration and large science missions our Agency has been tasked to deliver.

The majority of the heavy lift concepts analyzed by ACO during the last 3 years have been based on liquid oxygen / liquid hydrogen (LOX/LH2) core stage and solids booster stage propulsion technologies (Ares V / Shuttle Derived and their variants). These concepts were driven by the decisions made from the results of the Exploration Systems Architecture Study (ESAS), which in turn, led to the Ares V launch vehicle that has been baselined in the Constellation Program. Now that the decision has been made at the Agency level to cancel Constellation, other propulsion options such as liquid hydrocarbon fuels are back in the exploration trade space.

NASA is still planning exploration missions with the eventual destination of Mars and a new heavy lift launch vehicle is still required and will serve as the centerpiece of our nation's next exploration architecture's infrastructure. With an extensive launch vehicle database already developed on LOX/LH2 based heavy lift launch vehicles, ACO initiated a study to look at using a new high thrust ($\geq$ 1.0 Mlb vacuum thrust) hydrocarbon engine as the primary main stage propulsion in such a launch vehicle.

NASA is not the only aerospace entity that could benefit from a new hydrocarbon engine development. The Air Force has expressed a desire for a new American produced rocket engine to replace the RD-180 and an operable and easily refurbishable engine for applications in a reusable launch system. Emerging commercial launch vehicle companies (such as Space X, Kistler, and others) also have a keen interest in the utilization of new high thrust hydrocarbon engine that would allow them to reduce the total number of engines in their stages thereby reducing design and integration complexity and increasing vehicle reliability.

The premise of this study is to determine the thrust level requirement for a new LOX rich staged combustion hydrocarbon engine to meet future NASA heavy lift requirements and to develop conceptual launch vehicle concepts derived from this engine. This new engine could be utilized in future NASA exploration missions and could serve as a candidate engine for possible DOD and commercial applications.