SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (1) (1)

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LEVERAGING ADDITIVE MANUFACTURING FOR AFFORDABLE COMMERCIAL LAUNCH APPLICATIONS ENABLED BY THE AEROJET ROCKETDYNE ULTRA-LOW-COST BANTAM ENGINE FAMILY

Abstract

The commercialization of space depends on having affordable access to space. Propulsion is one of the major factors impacting the cost of a space launch system. With the goal of reducing propulsion costs by an order of magnitude, Aerojet Rocketdyne (AR) is developing the Bantam ultra-low-cost family of liquid rocket engines (LREs). The goal of this effort is to provide an architecture of LREs in the thrust range of 5,000 lbs to 200,000 lbs to support many different applications. Aerojet Rocketdyne is developing a new class of ultra-low-cost thrust chamber assembly (TCA) that can be produced via additive manufacturing techniques, enabling production of complex geometries in a single manufacturing step and significantly reducing production cost and lead time. An early step in this activity involved the design, fabrication and test of an engine designated as the Baby Bantam. The Baby Bantam engine was designed with a pressure-fed TCA to provide a vacuum thrust of 5 klbf using LOX/RP-1 propellants. The TCA was produced entirely by additive manufacturing. The Baby Bantam effort was performed over an approximate 15-month time period completed in CY 2013. The TCA was designed using a film-cooled approach. The entire TCA was fabricated from nickel-based alloy. Testing was conducted in April 2014. A total of 20 tests were performed. Hardware condition at the end of the test program was excellent.. After the Baby Bantam effort, an improved high-performance version of the TCA was developed. Under a DARPA contract. Key attributes of this TCA included: higher chamber pressure; LOX/RP propellants; regenerative cooling; fabrication completely via additive manufacturing and welded final assembly. Aerojet Rocketdyne completed the design and fabrication of this TCA in less than seven months at a fraction of the cost of using traditional manufacturing methods. The TCA hardware is now ready for test. Testing of the TCA is planned as part of a subsequent DARPA funded effort. This paper presents the history of the Bantam engine family, its development and current status. The paper also presents an overview of the additive-manufactured fabrication and discusses the benefits of the application of the additive manufacturing technology to LRE components. This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA). The views, opinions and/or findings expressed are those of the author and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.