NASA SBIR/STTR Technologies

Advanced Vortex Hybrid Rocket Engine (AVHRE)
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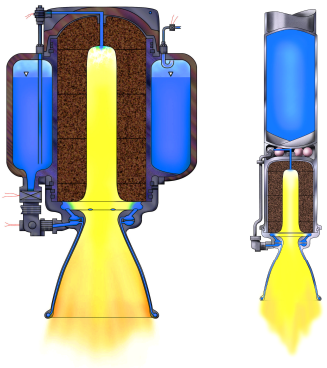
Proposal No.:04-II-X6.01-7813

Identification and Significance of Innovation

ORBITEC proposes to develop a unique Advanced Vortex Hybrid Rocket Engine (AVHRE) to achieve a safe, highly-reliable, low-cost and uniquely versatile propulsion system. The benefits of AVHRE result from the combination of four innovations: (1) the patented vortex injection technique which generates a coaxial vortex pair, driving high solid-fuel regression rates and improved combustion efficiency; (2) high-regression rate paraffin solid fuels; (3) patented regression sensor technology, and (4) a new fuel formulation innovation to control the solid fuel regression characteristics and provide improved structural integrity of the grain. These innovations simplify hybrid rocket design, development, and manufacture both inherently and by providing many practical design degrees of freedom that can be harnessed for a given application. The Phase II effort will design, develop, and test a 10,000 lbf, AVHRE-I chamber and a suite of practical AVHRE engineering design tools that will be delivered to NASA upon completion of the project.



Technical Objectives

1) Conduct an AVHRE mission and requirements analysis
2) Develop an numerical vortex hybrid flow field model that is confirmed by the Phase II experimental data
3) Develop a suite of practical AVHRE engineering design tools
4) Develop advanced hybrid fuel blends and corresponding large-scale grain production and instrumentation techniques
5) Conduct an in-depth AVHRE lab scale test program to characterize and refine engine performance over a e range of design parameters, fuel blends, and operational conditions
6) Complete the development and testing of a 300 lbf AVHRE chamber with both GOX and LOX
7) Design, develop, and test the 10,000 lbf thrust AVHRE-I Chamber with LOX to demonstrate and characterize AVHRE combustion behavior and solid-fuel regression rate behavior at practical scale
8) Provide thorough documentation and reporting of the work accomplished and of significant results.

NASA Applications

The AVHRE addresses key design, performance, and operational challenges of traditional hybrid rocket engine systems. If successful, this would catapult hybrid rocket systems into a highly competitive position for many Earth-to-orbit propulsion applications, where their inherent safety, simplicity, and low-cost could be competitively harnessed. The AVHRE hardware, analysis, and engineering design approaches developed during the Phase II program will be useful tools that NASA will benefit from. AVHRE addresses the need for high performance, low cost, reliable/safe, and flexible propulsion technology required for Earth-to-Orbit (ETO) applications and planetary missions. The fuel formulation technology demonstrated during the Phase I AVHRE project can also likely be adapted for producing ISRU fuel grains to meet Martian and Lunar propulsion needs.

Non-NASA Applications

AVHRE is expected to have a competitive position in reusable and expendable launch vehicles, sounding rockets, and upper stage propulsion systems. A new market is also emerging to provide suborbital launch vehicles for space tourists. The AVHRE could play a vital role due to its inherent safety and lower development cost. ORBITEC is also closely investigating the entertainment markets, including rocket car demonstrations at air shows, amusement rides, and model rocketry packages that would use the cartridge loaded AVHRE propulsion system. In addition to these applications, this new type of vortex combustion may have significant industrial benefits. For example, many classes of air-fired combustors can use the vortex combustion technology for improved combustion efficiency, potentially reduced emissions, and to reduce the required pre-processing.

Firm Contacts

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