Phase I Project Summary

Firm: Exquadrum Inc.
Contract Number: NNX12CG06P
Project Title: Hybrid Boosters for Upper-Stage Boosters (HUSB)

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

There is a demand for low-cost, reliable, on-demand, routine space access for less than $1 million per launch. The Hybrid Propulsion for Upper-Stage Boosters (HUSB) as the solution for launching nano and micro satellites in a cost-effective and responsive manner. The HUSB concept under development is based on a wooden round that requires no regular maintenance and a level of preparation and pre-launch inspection as straight-forward as those associated with contemporary air-launched munitions. Mission planning can be executed swiftly and with certainty using current Joint Mission Planning System hardware and processes. Within hours of notification, the delivery system can be loaded with existing support equipment onto a proven, field launch platform to place a satellite into the desired Low Earth Orbit (LEO).

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The objective of this proposed research effort is to demonstrate the feasibility of using gas generator hybrid engine technology to enable high performance and affordable upper-stages for flight tests and small, and nano-satellite, launching applications.

In support of this goal, the specific technical objectives of the program are summarized as follows:

1. Determine the vehicle requirements for flight test and small, and nano-satellite, launch missions using gas generator hybrid rocket engines.
2. Create a conceptual design of the gas generator hybrid rocket engine-based air-launch, missile system.
3. Create a conceptual, and then more detailed, design of the upper-stage gas generator hybrid rocket engine.
4. Demonstrate, by analysis, the mission pay-off of the gas generator hybrid rocket engine with an aerospike nozzle versus a high performance solid rocket motor using a conventional nozzle.
5. Fabricate a single modular thrust chamber.
6. Formulate and characterize a high-performance, upper-stage, solid rocket propellant.
7. Demonstrate a hot-fire test of a single modular thrust chamber.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

During Phase I, Exquadrum Inc., determined the requirements for a flight test and launch missions using this engine concept and demonstrated the feasibility of an aft-injected gas-generator hybrid motor for upper-stage boosters. A single element thruster was fired with a fuel-rich solid propellant grain which burned and provided a warm, fuel-rich gas that was then mixed with nitrous oxide in the main combustion chamber. The ignition of the nitrous oxide was spontaneous with the warm, fuel-rich gases and the combustion was stable.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

Small and Nano-Satellite Launchers
Hypersonic Flight Test for Propulsion and Materials Development
Sub-Orbital Sounding Rockets

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Commercial and Military Small Launch Vehicle
DoD Missile Defense
Civilian Space Tourism

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