Department of the Navy SBIR/STTR Transition Program

Topic # N202-129
Nosetip Ablation Sensor and Telemetry Interface Unit for Hypersonic Vehicle Thermal Protection Systems
Exo-Atmospheric Technologies, LLC

WHO

SYSCOM: ONR

Sponsoring Program: Office of Naval Research (ONR)

Transition Target: Fleet Ballistic Missile (FBM), Trident II D5

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Other Transition Opportunities: Conventional Prompt Strike (CPS) program
LGM-35A Sentinel (GBSD)
US Army Long Range Hypersonic Weapon (LRHW), Dark Eagle
US Air Force Advanced Rapid Response Weapon (ARRW)
Spaceplanes
Commercial Launch Vehicles
This technology is specifically tailored to high-enthalpy hypersonic systems with ablating thermal protection systems (TPS). The technology measures both temperatures in the TPS and the recession rate as the TPS ablates.

https://www.navy.mil/Resources/Photo-Gallery/igphoto/2001553085/

Notes: Image: Transition of ultrasonic recession gauge technology to re-entry applications on FBM warheads or hypersonic glide vehicles currently in development including Common-Hypersonic Glide Body (C-HGB)

Versions of this technology have previously undergone four (4) flight tests on sounding rocket testbeds including lofted and depressed (high Mach #) trajectories demonstrating survivability and operation in relevant environments.

WHAT

Operational Need and Improvement: A new sensing technology allows simultaneous measurement of nosetip shape, heat flux, and recession rate on flight test articles using a modern digital flight architecture combined with an innovative sensor array.

Specifications Required: Non-intrusive measurements on external thermal protection system (TPS) state using survivable sensors and avionics built for the extreme re-entry environment found on USN/DoN applications.

Technology Developed: A novel digital, microcontroller-based avionics package to operate the ultrasonic sensing array and to interrogate its results during flight. A custom sensor array optimized to accurately measure nosetip shape change during flight.

Warfighter Value: Direct measurement of nosetip shape, recession / ablation rate, temperature, and heat flux on USN/DoN applications will allow optimization of aerodynamic design along with verification and validation of aerothermal environment specifications. Advanced development would potentially allow flying a vehicle based on feedback from the measurement system. One of the core benefits of the novel ultrasonic sensing technology product is that aerothermal performance data on a given hypersonic vehicle can now be collected by a non-intrusive diagnostic and used for making recession, heat flux, shape, and temperature measurements in nosetips and other TPS regions (Leading edges, flaps, shock interaction zones) while being protected from the aerothermal environment by the existing aeroshell. The measurements are made without physically penetrating this protective layer. The non-intrusive nature of the ultrasound technology substantially eliminates the risk in flying this new technology on tests flights and provides an avenue for rapid commercialization since the technology is easy to integrate with existing TPS designs.

WHEN

Contract Number: N68335-22-C-0174 **Ending on:** Feb 19, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate gauging functionality in relevant high-enthalpy environments	High	Successful flight testing on technology demonstrating use	6	4th QTR FY21
Demonstrate high-temperature functionality in long duration environments	High	Succesful measurements during flight test on depressed trajectories	6	4th QTR FY22
Proof of concept testing to showcase multiplexing of multiple sensors for shape measurement	Medium	Benchtop testing of advanced avionics design with multiple sensors	4	4th QTR FY22
Final system level testing in a relevant laboratory environment	High	Arc-jet testing under representative conditions	5	4th QTR FY23

HOW

Projected Business Model: Exo-Atmospheric Technologies is developing this ultrasonic recession gauging technology as a stand-alone product that can be integrated with a wide variety of systems that requires TPS gauging and monitoring. The technology also allow retrofits onto existing platforms with relative ease further increasing potential sales. Exo-Atmospheric Technologies designs, develops, and fabricates all aspects of this technology product in-house and is capable of limited production runs and can readily scale up. The technology is also easily reconfigurable to meet the requirements of other platforms and thus its versatility will allow increased sales and other demonstration opportunities allowing for additional growth opportunities.

Company Objectives: Exo-Atmospheric Technologies seeks to directly integrate their ultrasound recession gauge technology with prime contractors directly involved with manufacturing and integration on of aeroshells and thermal protection systems on hypersonic vehicle platforms including ballistic RVs and glide bodies. The primary transition target is the nosetip TPS for warheads on the Fleet Ballistic Missile.

Potential Commercial Applications: This low-deployment-risk technology is also available for integration with a variety of other government and commercial applications. Non-external/aerodynamic applications include ablative insulation, throats, and integrated throat regions (ITEs) on solid rocket motors, and other erosive applications including turbines, furnaces, clutches, and braking systems for automobiles and aircraft. Commercial launch vehicles specializing in reusability have a need to monitor TPS recession for reuse and could also utilize the ultrasonic diagnostic to monitor TPS performance.

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