U.S. Army wants ideas for hypersonic control

The Advanced Hypersonic Weapon demonstrator lifts off from Kauai, Hawaii in 2011 on its first flight. The Pentagon is researching ways to control a hypersonic glider traveling at speeds over Mach 18.

U.S. Army

Hypersonic vehicles are hot, and not just in the literal sense that they generate tremendous heat as they streak through the sky at high Mach numbers. Hypersonic craft are a hot research topic in the U.S. Army and at the Pentagon because of the immense possibilities offered by a vehicle that can streak toward a target at speeds over Mach 18.

So far, the Army has flight tested technologies that could someday lead to an Advanced Hypersonic Weapon, a proposed hypersonic glider that is part of the Pentagon's Prompt Global Strike program, which calls for a conventional weapon that can hit any target on Earth within 60 minutes. Those tests have highlighted the question of how to control a vehicle blazing through the atmosphere at such high speeds. The service wants help with that question and has issued an Army Small Business Innovation Research solicitation seeking innovative ideas for controlling hypersonic vehicles. Responses were due in February.

The testing record explains the need for innovation. A 2011 test of DARPA's Falcon Hypersonic Technology Vehicle 2, or HTV-2, initially went well. After being boosted atop a Minotaur 4 rocket, it reached a speed of Mach 20 (24,501 kilometers per hour) for three minutes, and even managed to maintain controlled flight despite the initial shockwaves. But within minutes, the HTV-2 deliberately plunged itself into the Pacific Ocean after the onboard safety system detected an uncontrollable roll. Investigators blamed the mishap on the vehicle's skin peeling off in the intense heat.

During a 2014 test, the Advanced Hypersonic Weapon also had to be self-destructed because of an unspecified anomaly soon after launch.

The solicitation focuses on what it describes as a small, unmanned glider traveling at 20,921 kilometers per hour and at an altitude of 30 to 50 kilometers. It identifies potential "technology gaps" including "regions of non-continuum flow, laminar and turbulent flow transition, order of magnitude pressure variation between windward and leeward control force application, multi-phase flow, ablation issues, significant center of pressure shifts."

The solicitation calls for new aerodynamic control techniques for air-powered and unpowered hypersonic vehicles.

"Potential maneuver and control options might include propulsive, aerodynamic, blended methods and other innovative ideas," it says.

Hypersonic vehicles do present multiple control challenges, says Spiro Lekoudis, director of weapons systems for the Office of the Undersecretary of Defense for Acquisitions, Technology and Logistics.

"This flight regime necessitates very tight coupling of vehicle design and control system design, that allows the control system to effectively negotiate potential crossings of stable and unstable boundaries. The very existence of such boundaries can be catastrophic and thus designs robust to various perturbations is essential," Lekoudis says by email.

Lekoudis also cites difficulties such as rapid changes in aerodynamic load at hypersonic speeds, and changes in a vehicle's aerodynamic shape due to degradation of its materials.

Also, "the inability to replicate all flight conditions in ground facilities adds unknowns to a complex challenge," he adds.

Control is still an obstacle, but "no longer an insurmountable obstacle," according to Lekoudis. He does see other key issues to be solved, including thermal management and atmospheric degradation of materials.

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