Falcon Technology Demonstration Program
HTV-3X Blackswift Test Bed

Overview

The Falcon program is a joint venture by the Defense Advanced Research Projects Agency (DARPA) and U.S. Air Force. The program's objectives are to develop and demonstrate hypersonic technologies that will enable prompt global reach missions. The future vision for this capability entails a reusable Hypersonic Cruise Vehicle (HCV) that could deliver 12,000 pounds of payload at a distance of 9,000 nautical miles from the continental United States in less than two hours. The Falcon program will develop and demonstrate the technologies that will be required by a HCV: high lift-to-drag aerodynamics; high-speed, turbine-based combined cycle propulsion; high-temperature materials; thermal protection systems; and advanced guidance, navigation, and control. The Falcon program will address the implications of hypersonic flight and reusability using a series of hypersonic technology vehicles (HTVs) to incrementally demonstrate these required technologies in flight.

DARPA and the Air Force planned to leverage work begun under Falcon HTV for the HTV-3X Blackswift Test Bed, which would have demonstrated key hypersonic cruise vehicle technologies in a realistic flight environment by means of a reusable hypersonic aircraft test bed able to takeoff from a conventional runway under turbojet power, accelerate to Mach 6 speed under combined turbojet and scramjet propulsion, and land back on a runway.

The Falcon program also worked on developing a low-cost, responsive Small Launch Vehicle (SLV). The SLV would be capable of launching small satellites into low earth and sun-synchronous orbits and will provide the nation a new, small payload access to space capability. Thus, the Falcon program addresses two high-priority national mission areas, global reach and space lift.

Falcon Program

Small Launch Vehicle (SLV)

An ideal Falcon SLV would be capable of lifting a 1,000-pound payload to a 28.5° circular orbit at 100 nautical miles altitude. Its cost per launch objective is less than $5 million (FY03 dollars) if 20 launches occurred per year. Also, its launch operations timeline objective is significantly shorter compared to the existing launch services – the program goal is to reach alert status within 24 hours and launch within another 24 hours.

The Falcon SLV program selected Space Exploration Technologies to perform a responsive launch demonstration. The demonstration was to launch a small payload into orbit from the

Reagan Test Site at Kwajalein Atoll, Marshall Islands, while also demonstrating responsive launch operations. The first launch in March 2006 had an anomaly that caused the first stage engine to shut down 30 seconds into the flight. A second launch occurred one year later and achieved a fully successful flight of the first stage, successful stage separation, and a second stage burn. The payload simulator did not make it to orbit due to a second stage propellant slosh instability which caused the second stage to roll out of control.

The Falcon SLV program also selected AirLaunch LLC to develop a detailed design of their launch vehicle and to continue risk reduction activities. Phase 2C was the last portion of the DARPA/Air Force Small Launch Vehicle program. During phase 2C, AirLaunch conducted a number of test firings to further develop and characterize their vapor pressurization propulsion system. Those tests have been completed, and DARPA's SLV program has concluded.

Hypersonic Technology Vehicle (HTV)

The Falcon HTV program selected Lockheed Martin Aeronautics Co. to develop and design a low-risk, first-generation Hypersonic Technology Vehicle (HTV-1) integrated with state-of-the-art hypersonic technologies to address materials and fabrication challenges. A set of HTV-1 ground tests were conducted to develop and validate the vehicle's aerodynamic, aero-thermal, and thermal-structural performance as well as to validate advanced carbon-carbon manufacturing approaches. HTV-2 incorporates an advanced aerodynamic configuration, advanced thermal protection systems, and improved guidance, navigation and control systems. The HTV-2 detailed design has been completed and an aeroshell prototype fabricated.

In Phase III of the program, which is just beginning, DARPA will begin fabrication, assembly and integration of two HTV-2s and conduct two HTV-2 flight tests in 2009. HTV-2 will be launched by a Minotaur IV Lite rocket from Vandenberg Air Force Base, separate from the launch vehicle, and fly a hypersonic glide trajectory to a broad-ocean area impact near Reagan Test Site at Kwajalein Atoll, demonstrating long-duration thermal protection systems and advanced aerodynamic control features.

Blackswift Test Bed

The Falcon program had planned to develop a third Hypersonic Technology Vehicle (HTV-3) that would focus on reusable materials. Propulsion advances under the Falcon Combined Cycle Engine Technology program (FaCET) led to the decision to evolve HTV-3 into a Test Bed that will take off from a conventional runway, cruise at Mach 6, and land back on a runway. The test bed's nickname become Blackswift. Blackswift would have demonstrated key technologies such as efficient aerodynamic shaping for high lift to drag, lightweight and durable (reusable) high-temperature materials and thermal management techniques including active cooling, autonomous flight control, and turbine-based combined cycle propulsion. Flying this hypersonic test bed in a relevant flight environment would have permitted the future development of enhanced-capability reusable high-speed vehicles for intelligence, surveillance, reconnaissance, strike or other critical national missions. However, Congress made significant reductions in the amount of FY 2009 funds available to DARPA and the Air Force for the Blackswift Test Bed, and based on this, DARPA determined that the effort would not proceed.

The Blackswift Test Bed would have used an air-breathing propulsion system consisting of a turbine based combined cycle (TBCC) engine. Propulsion from take-off through supersonic flight regimes and landing would have been provided by turbojet engines. Propulsion for high supersonic and hypersonic flight regimes would have been provided by a scramjet engine (a capability referred to as a dual mode ramjet engine). The engine technologies are being developed under the DARPA High Speed Turbojet Engine Development (HiSTED) program for the high-performance turbojet and under the Falcon Combined Cycle Engine Technology (FaCET) for the scramjet, and these programs are continuing.

The DARPA/Air Force Falcon program continues to proceed with fabrication of the Hypersonic Technology Vehicles, and intends to conduct two flight tests starting in 2009.

Additional Resources

- Falcon program web site (includes low resolution image) – http://www.darpa.mil/tto/programs/falcon.htm .
- Media point of contact: Jan Walker, DARPA, (703) 696-2404, jan.walker@darpa.mil .

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