

Lightning Strikes Aurora

DARPA Awards VTOL X-Plane Demonstrator Contract

By AHS Staff



The US Defense Advanced Research Projects Agency (DARPA) announced on March 3 that it had selected Aurora Flight Sciences to continue on in the DARPA VTOL X-Plane program. The company was awarded an \$89.4M contract for Phases 2 (development) and 3 (flight test) for its LightningStrike hybrid-electric concept.

The VTOL X-Plane program began in 2013 with Phase 1 study contracts of \$11M to 17M each to The Boeing Company, a Sikorsky Aircraft-Lockheed Martin team, Aurora Flight Sciences and Karem Aircraft (in descending order of contract size).

When the program was launched, DARPA program manager Dr. Ashish Bagai stated that DARPA was looking “to challenge industry and innovative engineers to concurrently push the envelope in four areas: speed, hover efficiency, cruise efficiency and useful load capacity” — in short, a step change in utility. Specifically, the design objectives for the technology demonstrator are: a cruise speed of 300-400 kt (555-740 km/h); hover efficiency of 75% (up from 60% for a conventional helicopter); a cruise lift-to-drag ratio of at least 10 (up from 5-6); and a useful load of at least 40% of the vehicle’s gross weight of 10,000-12,000 lb (4.5-5.4 t).

Distributed Electric Propulsion

Aurora’s LightningStrike design uses distributed hybrid-electric propulsion — 24 ducted fans powered by an innovative synchronous electric-drive system. Both the wing and canard tilt for vertical take-off and landing. Aurora notes that “LightningStrike is the first aircraft in history designed to demonstrate” these key features, as well as the ability to maintain high efficiency in both hover and high-speed forward flight.

A Rolls-Royce AE 1107C turboshaft — the same T406 engine in the V-22 Osprey — is used, not for mechanical horsepower, but to drive three Honeywell International 1 MW (1,340 hp) electric generators; the total of 3 MW of electrical power is the equivalent of a typical commercial wind turbine. 18 ducted fans, providing relatively cool air, are integrated into the wing and six in the canards. Both the upper and lower surfaces of the box-like wings and canards provide lift in forward flight.

Rolls-Royce says that it will “contribute both proven components and innovative new technologies in turbo-electric distributed propulsion,” while Honeywell will “demonstrate technology that significantly improves

(All photos by Aurora Flight Sciences)

electric power-generation efficiency, power density and size.”

The demonstrator’s triplex-redundant flight control system builds on Aurora’s Centaur and Orion optionally manned and unmanned aircraft platforms. Aurora built a one-fifth-scale model demonstrator that had been readied for flight testing last September at Naval Air Station Patuxent River, Maryland, but it was decided to delay the testing until Phase 2 began.

The full-scale X-Plane is designed to weigh 12,000 lb (5.4 t) with a 40% useful load: 3,000 lb (1360 kg) of fuel and 1,500 lb (680 kg) of payload, which is primarily flight-test instrumentation. Pending successful completion of key program milestones in Phase 2, Aurora plans to conduct the first flight tests of the full-scale technology demonstrator in the 2018 timeframe as part of Phase 3.

Radical Improvements

DARPA states that the VTOL X-Program “seeks to provide innovative cross-pollination between fixed-wing and rotary-wing technologies and develop and integrate novel subsystems to enable radical improvements in vertical and cruising flight capabilities.”

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Bagai notes that Aurora's unique design is only possible through advances in technology over the past 60 years, in fields such as air vehicle and aeromechanics design and testing, adaptive and reconfigurable control systems and highly integrated designs. Aurora's distributed propulsion concept would be impossible with a classical mechanical drive system.

Aurora's Phase 2 design addresses many longstanding technical obstacles, the biggest of which is that the design characteristics that enable good hovering capabilities are completely different from those that enable fast forward flight. According to DARPA, among the revolutionary design advances to be incorporated in the LightningStrike technology demonstrator are: electric power generation and distribution systems to enable multiple fans and transmission-agnostic air vehicle designs; a modularized, cellular aerodynamic wing design with integrated propulsion to enable the wings to perform efficiently in forward flight, hover and when transitioning between them; and overactuated flight control systems that



can change the thrust of each fan to increase maneuverability and efficiency.

The Manassas, Virginia-based Aurora began as an unmanned aircraft system (UAS) developer and composite structures supplier, but today is also recognized as an innovator in composite aerostructures and in the vertical flight industry (see "A Composite View," *Vertiflite*, March/April 2013). The

company received the AHS Robert L. Pinckney Award in 2015 for building the S-97 Raider helicopter fuselage and the 2013 AHS Supplier Excellence Award for "flawless execution of main rotor pylon design and nacelle fabrication for the Sikorsky Aircraft/U.S. Marine Corps CH-53K."

