Boeing Completes Successful ABL Wind Tunnel Tests

A month-long series of wind tunnel tests conducted by Boeing has confirmed the design of components critical to the performance of the Airborne Laser (ABL).

The recently concluded tests focused on the design of the nose turret and the laser exhaust system. They will allow Team ABL -- comprised of Boeing, Lockheed Martin and TRW -- to proceed with detailed design of the weapon system that will destroy theater ballistic missiles in the boost phase of flight immediately after launch.

"These tests exceeded our best expectations," said Boeing engineer Victor Buonadonna, who directed the tests at the trans-sonic wind tunnel adjacent to Seattle's Boeing Field. "We came in with tight, efficient schedules and accomplished all the tasks we set out to do. We confirmed that the passive flow control of the turret is extremely effective and we also refined a series of exhaust design candidates."

Confirming the performance of Lockheed Martin's basic turret design, and obtaining all the necessary dynamic pressure measurements, allows Lockheed Martin to complete its detailed design of the turret, he said.

Buonadonna said the tests of the 104-inch nose turret design had two primary objectives. "We wanted to minimize dynamic pressure (on the turret surface) and also to optimize the passive flow control to reduce the effects of the shear layer."

Earlier tests disclosed that in certain turret positions, air flow - -called the "boundary layer" -- separated from the turret surface and created a turbulent "shear layer." That turbulence degraded the quality of the laser beam when the laser aimed through it. That could increase the time required to destroy the ascending missile. The wind tunnel tests "not only identified the best turret design but we also came up with a couple of candidates to further reduce the dynamic pressure with very moderate design changes," Buonadonna said. "That will produce better beam quality and less jitter, which will enhance the performance of the whole system."

Material and expertise for the successful wind tunnel tests came from across The Boeing Company. "We really used the whole company," Buonadonna said. "The six-percent-scale 747 model used for the turret tests came from Seal Beach, Calif., the aerodynamic engineers and wind tunnel model designers were from Wichita and Seattle, and a key contribution for the laser exhaust tests came from Boeing in St. Louis."

He explained that the St. Louis contribution took the form of "pressure sensitive paint" developed by Boeing Advanced Wind Tunnel Applications.

"The goal of the laser exhaust tests was to evaluate various flow control devices for minimizing exhaust effects on the airplane. We came up with 12 separate configurations that we'll use in trade studies of cost, drag, weight and complexity to identify the best one."

Buonadonna said the capability provided by the pressure-sensitive paint team in St. Louis allowed accurate and efficient observation and measurement of concentration and temperature variations on the aircraft due to the laser exhaust. "It was a diagnostic challenge that they pulled off without a glitch," he said.

The wind tunnel tests are the latest in a series designed to reduce risks before proceeding with the next steps in the ambitious missile defense program. The ABL weapon system will use a high-energy, chemical oxygen iodine laser (COIL) mounted on a modified 747-400F aircraft to shoot down theater ballistic missiles in their boost phase. ABL will play a key role in the nation's tiered, multi-service theater missile defense architecture. It will protect civilian and key military assets from attack by missiles such as the Scuds used by Iraq during the Persian Gulf War.

Boeing is responsible for battle management, overall integration of the ABL and attachment of the turret to the nose of the modified 747-400F freighter. The optics and control of the laser beam that fires through the turret's window are the responsibility of Lockheed Martin. TRW is designing and producing the weapon system's powerful laser.

Milestones:

Nov. 15, 1996: Air Force selects Team ABL for Program Definition and Risk Reduction (PDRR) phase of program

1996-2002: PDRR (build and demonstrate one ABL weapon system)

2nd Qtr 1998: Full-scale, Flightweight Laser Module Demonstration ABL Preliminary Design Review

2002: Shoot down a boosting theater ballistic missile; ABL Residual Operational Capability available if needed

2003-2005: Engineering Manufacturing and Development (EMD)

2005-2008: Production (IOC 3 aircraft 2006, FOC 7 aircraft 2008)

ABL: http://www.boeing.com/defense-space/military/abl/

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