Boeing Completes Successful ABL Tests

After a month of tests in a University of Washington water tunnel, Boeing engineers have identified a trio of design options to enhance the aerodynamic performance of a key component of the Airborne Laser (ABL) program: the 104-inch nose turret that aims the weapon's laser at theater ballistic missiles to destroy them in flight.

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. It will protect civilian and key military assets from attack by missiles such as the Scuds used by Iraq during the Persian Gulf War.

"The water tunnel tests worked very well for us in three major ways," said Boeing engineer Victor Buonadonna. "First, we confirmed that our existing design concept will work as conceived. Second, we reduced the number of designs we will study in wind tunnels later this year from 15 down to the three that showed the greatest promise. And third, we got the information at very low cost by using the water tunnel."

Buonadonna said water tunnel tests ending in June were completed for about $25,000 compared to wind tunnel costs which average between $20,000 to $30,000 per day.

Water tunnels are ideal for investigating fluid flow over solid spherical surfaces - in this case the turret to be mounted on the nose of a modified Boeing 747-400 Freighter chosen for the weapon system platform. Through observation of the colored streams of water as they flow over the structure, engineers can identify problems with the flow and change the structure's shape to correct them.

In the tests, Boeing confirmed what earlier analysis had shown: in certain turret positions, the air flow - called the "boundary layer" - separated from the turret surface and created a turbulent "shear layer."

"The turbulence degrades the laser beam quality when the laser aims through it," Buonadonna said. "That results in a blurred spot on the target that increases the time required to destroy the target. The water tunnel studies allowed us to test many configurations for reducing the turbulence and improving beam quality using a concept called 'passive flow control'," he added.

Buonadonna explained that the concept was suggested in 1995 by Dr. Bob Breidenthal, University of Washington aerodynamics professor, who was working with Boeing in a series of ABL-related wind tunnel tests. In those tests, the passive flow control concept proved so effective that it became the baseline for the Boeing ABL turret aerodynamic design.

The concept employs suction at the base of the turret to eliminate or decrease the shear layer. That suction is provided by a "speed bump" that produces a partial vacuum behind it, "pulling" the boundary layer back onto the aft portion of the spherical turret. The system is passive in that no mechanical pump is required.

"With the successful conclusion of the water tunnel tests, we are ready to focus the upcoming wind tunnel tests on the three designs," Buonadonna said. He added that Boeing is "very confident that the November wind tunnel tests will finalize the turret design and produce the design efficiencies we want."

Boeing is responsible for the aerodynamic design of the turret, its attachment to the nose of the modified 747-400F and integrating the weapon system onto the aircraft. 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

May 1994:

- Team ABL (Boeing, Lockheed Martin and TRW) and Rockwell awarded 33-month, Concept Definition contracts

July 8, 1996:

- Team ABL submits response to RFP

Nov. 15, 1996:

- Air Force selects Team ABL for Program Definition and Risk Reduction (PDRR) phase of program.

1996-2000:

- PDRR phase one (build one ABL weapon system)

2000-2001/2:

- PDRR phase two (flight test & demonstration)

2001/2-2004:

- Engineering Manufacturing and Development (EMD)

2004-2008:

- Production (Initial Operational Capability -- 3 aircraft 2005/6; Full Operational Capability -- 7 aircraft 2008)

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