Wind-Tunnel Testing Under Way for Boeing 7E7

Low-speed wind-tunnel tests have started for the Boeing 7E7, and work is nearly complete on the model that will be used in a first round of high-speed wind-tunnel tests for the new airplane.

Wind-tunnel models allow experts to test many different configurations for the proposed airplane. Low-speed tests measure airplane performance with a variety of high-lift surface settings to simulate takeoff and landing conditions.

During the first round of high-speed tests Boeing will test four distinctly different wing designs at the Boeing Transonic Wind Tunnel in Seattle. Each wing has its own unique features ranging in size, sweep and design details.

"On the 767 program, we performed wind-tunnel tests with more than 50 different wing configurations," said Mike Bair, senior vice president of the 7E7 program. "On this program, we likely will test no more than a dozen."

Fewer tests are needed today because modern computational fluid dynamics (CFD) tools allow designers to consider and run virtual experiments on designs with a higher degree of confidence than ever before. Only those designs that show real promise will make it to the wind tunnel.

"Our computer modeling tools allow us to predict much more closely what will transpire in the wind tunnel, which then accurately verifies the flight performance of the airplane," Bair said. "This process gives us the opportunity to refine our designs with computers long before we ever get to the wind tunnel. We are looking for the design that will allow the airplane to fly most efficiently."

Hundreds of sensors are embedded in the model to measure pressure to determine the in-flight loads as well as provide valuable diagnostics of the aerodynamic performance of a given design. These measured pressures also help calibrate the CFD tools to make them even more accurate.

The results of the first round of tests will give designers confidence in the aerodynamic performance levels they seek on the 7E7. Subsequent test rounds will provide further design refinement and more accurate airplane performance predictions. Two additional rounds of low-speed and high-speed testing will be conducted during the development of the 7E7. Also, wind-tunnel tests for noise, icing, flutter and propulsion are scheduled through early 2006.

"We know a lot about our new airplanes before they are ever flown, through core competencies of computational fluid dynamics and wind-tunnel testing," Bair said. "It's why we can be confident in the safety and integrity of the first airplane and every airplane that follows."

Model Making

It takes nearly four months to build a wind-tunnel model. The high-speed model currently in development will be a 3.9-percent scale model of the baseline 7E7, measuring about 2.2 meters (88 inches) long with a wing span of 2.2 meters (88 inches).

Boeing model design engineers create the high-speed model using CATIA, a sophisticated CAD/CAM program. Programmers use the CATIA model to create Numerical Control programs that help fabricate the airplane on computer-controlled milling machines. Because of the small scale of the model and the need to be very precise -- tolerances are often within 0.15 millimeters (0.006 inches) -- much of the model is created by hand.

"Building wind-tunnel models is a unique skill," Bair said. "Our model designers and machinists take great pride in their work and are among the most skilled in the world."

Boeing Transonic Wind-Tunnel Background

The Boeing Transonic Wind Tunnel, originally opened in 1944 for testing of the B-47, has undergone dramatic upgrades in the last five years. The changes include a new drive system with a 55,000-horsepower variable speed motor. Tunnel environment and air quality in the test section were improved with a circuit extension and the addition of a full-flow heat exchanger and dehumidifier system. In addition, redesigned fan blades have been installed along with new turning vanes, a flow conditioner and a bell mouth. A variety of model measurement methods and data acquisition equipment are selectively available.

The changes make the Boeing Transonic Wind Tunnel a state-of-the-art facility, ready to provide service for the second century of flight.

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