

Boeing Feature Release: Testing, Testing...

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Flight-Testing for the Boeing 777-300ER Ensures Customers Receive a Service-Ready, Safe and Airworthy Airplane

The day is sunny and clear, and almost anywhere in the world it would be a picture-perfect day. But not today at Edwards Air Force Base, Calif. With the clear skies comes a brisk 10-knot wind from the southwest -- 5 knots more than is allowed for runway testing to occur.

It is just after sunrise and the team that Boeing has temporarily reassigned to the Southern California Air Force base is energetic and ready to go. But today's plans are halted when word comes the winds are too high.

A message on a communication board leaned against a yellow storage tub reads "preflight TBD > 11 a.m."

The problem is that it is not yet 6 a.m. And the 45-minute drive back to hotels in Lancaster and Palmdale, Calif., causes everyone to remain on-site.

As the team arrives at the borrowed Air Force facility set up as its operations center, animated banter ranges from world events to airplane testing. But mostly it is the wind they talk about.

And they wait.

Ensuring safety, security

As with all of its new-model airplanes, Boeing intends to perform flight and ground testing on the two 777-300 Extended Range flight-test airplanes. Flight tests began Feb. 24 with the first flight of WD501, the first flight-test airplane. A second flight-test airplane, WD502, entered the flight-test program in early April.

"Flight-testing is extremely important to Boeing and the U.S. Federal Aviation Administration as well as the traveling public, who expect nothing less than uncompromising safety and security from a Boeing-built airplane," said Joe Kranak, Boeing flight-test chief engineer.

"The primary purpose of flight-testing is to demonstrate to ourselves and to the world's regulatory agencies that our airplane meets or exceeds all of their requirements and is service-ready. Should problems arise during this process, the team is poised to respond quickly and ensure that testing can proceed."

The testing at Edwards AFB is just one part of the 777-300ER's 1,600-hour flight- and 1,000-hour ground-test program, which is expected to culminate in certification of the airplane by the FAA in early 2004. First delivery is scheduled for April 2004 to International Lease Finance Corp., and its customer Air France.

The world is its runway

No place in the world is too far away and no conditions too extreme to test a Boeing commercial airplane.

The Boeing 777-300ER flies over Washington state. The two 777-300ER airplanes will fly 1,600 hours as part of the flight-test program, which will culminate in the certification of the airplane by the U.S. Federal Aviation Administration in early 2004. - Photo by Joe Parke

"We go all over the world to test," said Frank Santoni, 777 chief test pilot. "We typically go to Iceland for the crosswinds and tailwinds, to South America for the natural ice, and to the Australian outback for hot weather. We go to airports outside of our home base of Puget Sound to test, because they are more efficient for the different types of testing that are required."

The team performs its critical tests at Edwards Air Force Base, primarily because it's not too busy with commercial traffic and has long runways.

While on these remote assignments engineers will test the airplane under extreme conditions, from minus 29 degrees Fahrenheit and foggy in Glasgow, Mont., to minus 54 F in the Baffin Islands in Canada, to 95 F and humid in Singapore to dry and 112 F in Alice Springs, Australia.

While at these locations every replaceable component must be tested, removed and replaced in a variety of harsh environments.

Launching a new airplane, and the associated flight-testing process, involves a huge investment of time. According to Larry Muri, lead flight-test mechanic, the flight-test team is responsible for verifying compatibility, durability, longevity and maintainability of each airplane, the associated components and any innovations. The flight-test group also works in concert with the FAA each step of the process.

Compounding these challenges, the team often works 12- to 16-hour shifts, while living out of a suitcase and traveling with the plane to its destinations, often for weeks at a time.

The work of preparing for a flight test begins before the airplane is built. Schedules and tests are approved before the airplane gets to the production stage. Then, once the plane is airborne and lands safely after completing its first flights, comprehensive tests begin and continue nearly around the clock for months.

Changes are primary focus

In order to certify the 777-300ER to enter passenger service, the FAA requires Boeing to perform numerous tests. Many of the tests for the 777-300ER are a result of changes from earlier 777 models: the 777-200, 777-200ER and 777-300 airplanes.

The 777-300ER is based on the popular 777-300 airplane. The 777-300ER extends the 777-300's range by more than 1,700 nautical miles to 7,420 nautical miles or is able to carry an additional 55,000 pounds of cargo.

Other changes to the 777-300ER include

- Extending each wing by 6.5 feet, and adding raked wingtips to improve the overall aerodynamic efficiency. Raked wingtips, similar to those on the 767-400ER, help reduce takeoff field length, increase climb performance and reduce fuel burn.
- Strengthening the airplane's body, wing, empennage and nose gear to support the increased takeoff weight of 759,600 pounds.
- Installing new main landing gear, wheels, tires and brakes.
- Adding a supplementary electronic tailskid. This software feature helps prevent inadvertent scraping of the tail on the runway at takeoff or landing by commanding elevator movement if the airplane's nose-up attitude exceeds preset limits.
- Modifying the struts and nacelles to accommodate the significantly higher-thrust engines.
- Providing a new higher-thrust derivative of the General Electric GE90 engine than is offered on the existing 777s. The new engine provides 115,000 pounds of thrust -- the most ever on a commercial jetliner.

"These areas will be the focus of the 777-300ER's year-long flight-test program," Kranak said.

The pilot's role in flight-testing

Boeing Commercial Airplanes pilot Frank Santoni has been involved in the 777 since the testing of the first airplane in the program.

"Not even 20 percent of what we do is flying the airplane," Santoni said. "In addition to being pilots, we're also engineers. We work with engineering and manufacturing to build new features, and we work with sales and marketing to help sell the airplane."

Test pilots are the first to find out if Boeing ideas really work.

"It's a great job if you like to fly, but it's a different job from that of an airline pilot," Santoni said. "We not only test the airplane in the typical flight envelope but we also spend a great deal of time outside of where an airline pilot will fly. This ensures that the airplane behaves as expected should it ever be exposed to these unusual conditions. We also are faced with understanding and evaluating any changes we introduce due to discoveries during our testing."

The idea of a test program is not to take an airplane beyond its limits; the purpose is to find the limits so warning systems can be set to prevent pilots from reaching those limits.

"The bottom line is we help make changes that improve the airplane's performance, passenger comfort and the pilot's ability to fly the airplane," Santoni said.

Boeing's policy for flight-testing allows only pilots on board for an airplane's first flight. Gradually essential personnel, such as engineers and flight-test crew are allowed on to perform onboard analysis.

"These folks can make decisions and change testing immediately, if needed," Santoni said. "We beam the data to the ground, but we also can analyze the data while we're still in the air. The onboard crew is able to perform three or four experiments to maximize our time and minimize costs."

Not your typical airplane

The 242-foot-long 777-300ER is filled with rows of computer workstations and printers, racks of data storage

and 45 60-gallon water barrels. During flights an engineer moves water among the barrels, shifting the weight between the front and rear of the airplane, which changes the airplane's center of gravity.

Computer workstations allow engineers to view what's happening on the flight deck. Video screens show the pilot's flight and navigation displays, and each screen includes a digital time stamp. If something goes wrong, the videotape relays can pinpoint the exact sequence of events.

Two ground crews accompany the Boeing 777-300ER when it is at remote locations. The day crew is shown here changing a tire on WD501 at Edwards Air Force Base, Calif. To prepare for testing at the Southern California air force base, Boeing sent nine semi-trucks loaded with 54 tire and wheel assemblies, 36 sets of brakes and 15 LD-3 cargo containers with spare parts, test equipment and tools to Edwards. - Photo by Ken Dejarlais

Also inside the airplane are temporary sidewalls and overhead ceiling panels, which allow anyone on board to see the roomy open space in the crown of the airplane. Eventually this space will house an overhead flight attendant and crew rest.

While there are only about 75 passenger seats on board, the airplane eventually will be refurbished with a new interior and seats. The 777-300ER can carry 365 passengers in a three-class configuration.

At the rear of the airplane is a giant reel that houses a trailing cone. The cone is dragged behind the airplane during flight, and measures the static pressure (altitude) behind the airplane. During the test, the cone is extended up to 125 feet behind the airplane, so the instrument is outside the pressure field the airplane creates as it moves through the air.

Hundreds of tests

In the early stages of the flight-test program, as is typical with any new model, initial testing focused on clearing all major facets of the basic flight envelope required prior to the granting of Type Inspection Authority by the FAA. Once the team obtained TIA in mid-March, it began testing immediately, interspersing certification tests along with ongoing engineering tests.

Types of certification tests scheduled include maximum gross weight takeoffs, check climbs, stall-speed performance and buffet-boundary performance. Engineering data collection has involved brake anti-skids tuning, Brake System Control Unit software evaluations, tail strike protection development, landing gear actuation evaluation, as well as a number of other tests.

While operating out of Edwards, the WD501 team conducted numerous Boeing and FAA certification tests including takeoff performance, abuse takeoffs and ground minimum control speed tests. Other tests at Edwards included stability and control, air minimum control speed, stall characteristics, GE90-115B engine 15-knot tail wind and inlet compatibility demonstrations, and flight control modal suppression function evaluations.

Beginning in late summer and continuing through the third quarter, both airplanes will be used for extended operations and systems trials.

So how's it going so far?

"Our pilots and engineers are quite pleased with the performance of the test airplane," said Lars Andersen, Boeing 777 Longer Range program manager. "Both of our 777-300ERs have been remarkably trouble free, with none of the major surprises that are sometimes typical of a new model."

According to pilots, crews say they have difficulty distinguishing the 777-300ER from the current 777-300 model. "Even with the airplane's new semilevered landing gear, our pilots haven't noticed a significant operational difference, other than the improved performance afforded by the GE90-115B," Andersen said.

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