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PHOTO: The 747-8 Freighter, the longest 747 ever built, taxis out to the Paine Field runway in Everett, Wash., for its first flight on Feb. 8.

747

leap

The 747-8 Freighter is defined by its new technology and efficiency

by Lauren Penning and photos by Bob Ferguson

“The 747 still reigns as queen of the skies.”

– Steve Huard, the 747-8 senior project manager, to a *Seattle Times* reporter

When the 747-8 Freighter lifted off from Paine Field in Everett, Wash., on Feb. 8, the event marked a new chapter in the storied history of the 747 program. The 747-8's first flight came just one day shy of the 41st anniversary of the first flight of the 747—the world's first twin-aisle jetliner—which took off from the same airfield in 1969.

Although the iconic “hump” identifies the new airplane as a 747, it is the latest technology and improved efficiency that distinguishes the -8 model. “Our customers are really excited because they will get a product that is more efficient,” said Mo Yahyavi, vice president and general manager of the 747 program.



Stretching 250 feet (76.2 meters), the 747-8 is 18 feet 4 inches (5.6 meters) longer than any previous 747; and the wingspan, at 225 feet (69 meters), is 13 feet (4 meters) wider.

Compared with its predecessor, the 747-400F, the 747-8 Freighter will have nearly equivalent trip costs and 16 percent lower ton-mile (tonne-kilometer) costs, in addition to room for 16 percent more revenue cargo. The new airframe also is more environmentally friendly, with a 30 percent smaller noise footprint and a 16 percent reduction in carbon emissions, thanks to a newly designed wing and fuel-efficient engines similar to the ones powering the 787 Dreamliner.

Boeing studied how to replace the 747-400 for years. "The missing piece was always the engines," said Jim Peterson, 747-8 Propulsion leader. The 747-8 team got its break with the development of the two-engine Dreamliner. The 787 engines provided the right amount of thrust for a four-engine 747 and were a good replacement, with some modification. Thus was born the GENx-2B powerplant for the 747-8, manufactured by General Electric.

The new 787 engines, however, were larger than any ever used on production 747s. "The wing needed to accommodate them,"

said David Loffing, Product Development engineer supporting the 747-8 Program Integration Team. The wing also needed to be redesigned to maintain the same takeoff and landing performance as the -400 while carrying 16 percent more payload. "It was a really interesting problem," Loffing said.

Looking down the edge of the 747-8 wing to the tip, the human eye can spot the complex curvature of the wing and how it accommodates the engines. But manufacturing advanced designs such as the 747-8 wing would not be possible without proper tooling. "What the team was trying to achieve with aerodynamics in the new wing design, for example, also had to structurally support everything with proper wing thickness. At the same time we had to keep an eye on the factory to see how we were going to fasten it, sequence it and maintain it," said Michael Teal, 747-8 chief project engineer.

The design team counted on Boeing Fabrication. The raw material for the wing skins ranges from 34 feet (10 meters) to more than 100 feet (30 meters) long and is more than an inch (2.54 centimeters) thick in places. Traditional methods to contour the wing skin included shot peening, which involves spraying



PHOTO: The General Electric GENx-2B engines for 747-8 are a modified version of the fuel-efficient GE engines developed for the 787 Dreamliner.

thousands of pounds (kilograms) of tiny, cut steel wire at the wing skin. This method would not work on the thicker parts of the 747-8 wing skins, so the team used a new technology—laser peening.

“We are the first in the world to use this tool with this type of application,” said McKay Kunz, material and process technology engineer, who works at the Fabrication facility in Fredrickson, Wash. The airplane industry has used laser peening for fatigue or compression testing and peening on fan blades, but never before for forming wing skins. Now, the longest part on the 747-8 wing, the lower enclosure panel, receives a quarter-million precisely placed laser spots.

Boeing’s fabrication team pushed the limits of another new technology, too—fabricating monolithic parts. Instead of attaching individual stringers (to provide structural support) in the wing-to-body join area, requiring a more complex fabrication process and more work to build, the team adapted a machine used to build 737 skins to cut a 9,800-pound (4,445-kilogram) block of solid material into a final 747-8 part that weighs 588 pounds (267 kilograms). “The first part we cut went on the airplane,” said Tom McDonald, team leader for monolithic side-of-body 747-8,

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“Two things haven’t changed: It still looks like a 747 and it still flies like a 747, and quite frankly, it just doesn’t get any better than that.”

– Mark Feuerstein, command pilot of the first flight, speaking at news conference afterward



Test time

Planning the flight-test program for the 747-8 Freighter began early in the design phase

by Patrick Summers

Before the first 747-8 Freighter is delivered to launch customer Cargolux later this year, the airplane will complete months of rigorous testing that began in earnest with first flight.

"The flight-test team represents several thousands of people who have poured their hearts and souls into bringing the airplane to this point and making it a reality," said Mark Feuerstein, chief 747-8 pilot who commanded the first flight on Feb. 8.

The flight-test program will verify the design and performance specifications of the 747-8, its compliance with Federal Aviation Administration and other regulatory requirements, and its ability to meet customer expectations. That's a big job. Over the next several months, every component, system and flight maneuver will be tested under routine and extreme operating conditions.

Planning for the 747-8 test program began several years ago. "As the airplane goes through early concept design, firm configuration and into assembly, we're designing the instrumentation and the flight-test hardware specific to that airplane," said Dennis O'Donoghue, vice president of Boeing Test & Evaluation. "Then we fabricate, assemble and install it, all while the airplane is going down the production line."

The 747-8 flight-test program will use three freighters and two Intercontinental (passenger) airplanes. "We calculate the number of test airplanes based on the number and type of tests we need to complete, the estimated flight hours necessary to meet the testing requirements and the time we have to get it all done," explained Andy Hammer, 747, 767 and 777 test program manager.

Flight testing of the Intercontinental is scheduled to begin in early 2011.

One challenge for Boeing Test & Evaluation is executing simultaneous flight-test programs for both the 747-8 and the new 787 Dreamliner. The solution, O'Donoghue said, was to geographically separate the testing. The 787 flight tests will take place mostly in the Puget Sound area. Initial flight testing of the 747-8 Freighter is being carried out at Moses Lake in Eastern Washington, with the remaining tests in Palmdale, Calif.

Flight testing on the first 747-8 Freighter is scheduled to be completed in the third quarter, with the airplane then refurbished and delivered to launch customer Cargolux by the end of the year. ■

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“It’s a great experience to be able to see a brand-new airplane go flying up high. It makes all our hard work worth it.”

– Joe Farra, one of many Boeing employees who lined the runway to watch the 747-8 take off for the first time

PHOTO: The 747-8 continues a Boeing legacy of 747 Freighters that today carry more than half the world’s air freight.

commenting on the quality of the new part’s design, fit and finish.

“Our customers see the 747-8 as a departure—an improvement to what they already have,” Yahyavi said. “They have a confidence that they are getting a better product.”

That confidence comes, in part, from the Freighter Working Group. Starting in early 2005, Boeing met with technical experts in the cargo community to discuss the next generation of freighters. Pilots and operators of 747-400 Freighters wanted the new airplane to fit easily into existing 747 fleets. So the design team made sure that the new airplane could use the same ground-support infrastructure as the -400. The only exception is a beefed-up tow bar, necessary because of the aircraft’s added weight. Meanwhile, the systems integration team focused on making the flight controls mimic the handling characteristics of the -400. “Our goal is to have it feel and handle identically to the -400 while still getting increased performance and better reliability,” said Debra Fahey, 747-8 flight controls integration.

Another takeaway from the meetings was a better understanding of what features customers wanted on the airplane—and how to reduce options and add value. This strategy has reduced the number of options on the new freighter by about 70 percent, simplifying the buying process for the customer and upping the resale value because there is increased commonality between customer fleets.

This also has benefits on the factory floor. “A good Lean production system is built on stability,” said Paul Nuyen, vice president of 747-8 Manufacturing. “Having a more stable configuration allows us to get the production system on a real rhythm.”

The team also needed to prepare the factory for the larger dimensions of the 747-8 airframe and related materials. “Lots of things needed to be gauged up,” said Tom Miller, tooling engineer lead for the 747-8. This included creating or reworking 2,046 tools. For example, in wing-to-body final assembly, more than 60 percent of the tools are new. “We had management down on the factory floor asking us what we needed to get the job done,” said Jose Diaz, mechanic on the 747-8.

The new tools are designed to be more ergonomically friendly. The automated spar assembly tool, for example, is “a leap into the future” for the program, Miller noted. Instead of performing hand drilling, an automated tool guides the process.

As the program assembled the major components of the initial 747-8 Freighter, late maturity of designs caused more rework than expected and first flight was pushed back to 2010. Although this was disappointing, lessons learned on the 747-8 Freighter are being applied to the Intercontinental, the passenger version of the





747-8 that will follow. The Intercontinental design is more complex because of the passenger interior and added stretch to the aircraft's hump. "We have a more thoughtful resource plan and NRPD [non-recurring product development] process," said Todd Zarfos, vice president of 747 Engineering. The result: "We have had more than 50 weeks of 100 percent performance, compared with 95 percent, which is a traditional recurring metric," he said.

Assembly of the Intercontinental is scheduled for mid-2010, and "the improvements on the engineering performance of the Intercontinental are a good indicator that we will have a better time putting it together," Nuyen said.

Meanwhile, with first flight of the freighter accomplished, the team needs to remain focused, according to Yahyavi. "We are entering the flight-test phase, and like every development program, we have to go through that process, and we will find things that need to be addressed. In the meantime, we need to finish work on the production system to get the airplanes ready on time for our customers." ■

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***"It was a big day
for a big airplane."***

– Mark Feuerstein, command pilot of the 747-8 on its first flight, speaking afterward at a news conference

PHOTO: After a successful first flight that lasted 3 hours, 39 minutes, the 747-8 returned to Paine Field in Everett, Wash., where it is shown here in the golden light of late afternoon.



Meet the *launch customers*

Boeing has 108 orders for the 747-8, of which 76 are for the freighter. Below are brief profiles of the launch customers for the biggest and most efficient 747 ever.

Company: Cargolux Airlines International S.A.

President and CEO: Ulrich Ogiermann

Fleet: All-Boeing operator of 14 747-400 Freighters; launch customer for the 747-8 Freighter, with an order for 13

Markets served/major routes: Cargolux is one of the world's leading cargo airlines, operating scheduled and charter services on a network covering 90 destinations in all continents. The company has 40 years of experience and, measured in ton-miles (tonne-kilometers) flown, ranks as the eighth-largest cargo airline worldwide. Cargolux is an integrated transportation company, operating exclusively with freight forwarders. It is the largest all-cargo airline in Europe.

What you didn't know: Cargolux is an expert in the transportation of special cargo, including live animals. Recently, two *hippopotamus amphibius* traveled on board of a Cargolux flight from Tel Aviv's zoological center to their new home in a zoo in Almaty, Kazakhstan.

Company: Deutsche Lufthansa

Chairman of the Executive Board and CEO: Wolfgang Mayrhuber

Fleet: Total for the Lufthansa Group is 570 airplanes, including 63 737 Classics (-300, -500), 11 Next-Generation 737s (-600, -700, -800), 6 767-300ERs (Extended Range), 4 777-200ERs, 30 747-400s and 19 MD-11 Freighters; Lufthansa is a launch customer for the 747-8 Intercontinental, with 20 on order

Markets served/major routes: Deutsche Lufthansa operates a global network that, together with its Star Alliance partners, performs more than 800,000 flights annually.

What you didn't know: Deutsche Lufthansa is the largest airline by fleet size in Europe. Wholly owned subsidiary Lufthansa Technik, which provides aircraft maintenance, repair, overhaul and modification services, is a completion center for Boeing Business Jets, installing highly customized interiors.



Company: Nippon Cargo Airlines

CEO: Tadamasu Ishida

Fleet: Operator of eight 747-400 Freighters; launch customer for the 747-8 Freighter, with 14 on order

Markets served/major routes: Nippon Cargo's worldwide network covers 15 major cities in seven countries in Asia, America and Europe. From Tokyo's Narita International Airport, Nippon Cargo flies to Amsterdam; Anchorage, Alaska; Bangkok; Chicago; Hong Kong; Los Angeles; Milan; Nagoya and Osaka, Japan; New York; San Francisco; Seoul, South Korea; Shanghai; and Singapore.

What you didn't know: Nippon Cargo Airlines is Japan's only all-cargo carrier. As part of the "flying wheelchairs" project, 59 Japanese high schools recondition used wheelchairs, which the cargo carrier then transports to people in need around the world, particularly in Southeast Asia.

"It's the culmination of a lot of 'working together' meetings with Boeing, Cargolux and Nippon Cargo. And it's fantastic to see the airplane fly after all this work."

– Sten Rossby, Cargolux chief technical pilot

PHOTO: The 747-8 Freighter climbs away from Paine Field in Everett, Wash., on its first flight, one day shy of the 41st anniversary of the first flight of the original 747 in 1969.

