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GE Engine Services

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Boeing Selection of GE Engine A "Dream" Come True

In April, Boeing announced its selection of GE power for the new 7E7® Dreamliner aircraft, prompting David Calhoun, president and CEO of GE Transportation, to state: "This makes for a huge day in the history of our jet engine business."

Huge because the 7E7 is Boeing's first, all-new commercial aircraft in a decade. It is expected to enter service in 2008 and carry 200 to 250 passengers up to 8,300 nautical miles. Once the Dreamliner becomes available, airlines are expected to begin retiring their older 757® and 767® planes, transforming fleets worldwide. In all, Boeing expects to sell between 2,000 and 3,000 of the twin-engine 7E7 aircraft over the next 20 years.

To share in this opportunity, GE is developing its first all-new engine in a decade. Currently dubbed the GENX engine, this 55,000 to 70,000 pounds-thrust powerplant is being designed to meet the specific requirements of 7E7 customers, including such aggressive goals as achieving 20 percent lower fuel consumption.

"Our new engine for the 7E7 is the culmination of technologies in which we've made

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The first Boeing 777-300ER™ takes off.

World's Largest and Most Powerful Jet Engine Gets Clearance for Takeoff

At one point a dream yet to be realized, the GE90-115B has been years in the making. Now, 11 months after extensive flight testing, the US Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) have certified the Boeing 777-300ER that will be exclusively powered by the GE90-115B. In May, ILFC's customer, Air France, will be the first operator to enter the 777-300ER into revenue service.

This momentous occasion has already begun to change the landscape of jet engine design with its swept fan blade innovation, which enables the engine's unprecedented 115,000 pounds of thrust and contributes to low fuel burn signature.

Three Boeing 777-300ER test aircraft completed nearly 1,500 flight- and 1,000 ground-test hours since the testing began last year.

GE is also continuing its aggressive, four-year reliability and maturation test program on the GE90-115B, in which three engines will undergo simulations that replicate 20 years of flight service.

The GE90-115B is the exclusive engine for Boeing's 777-300ER and 777-200LR aircraft.

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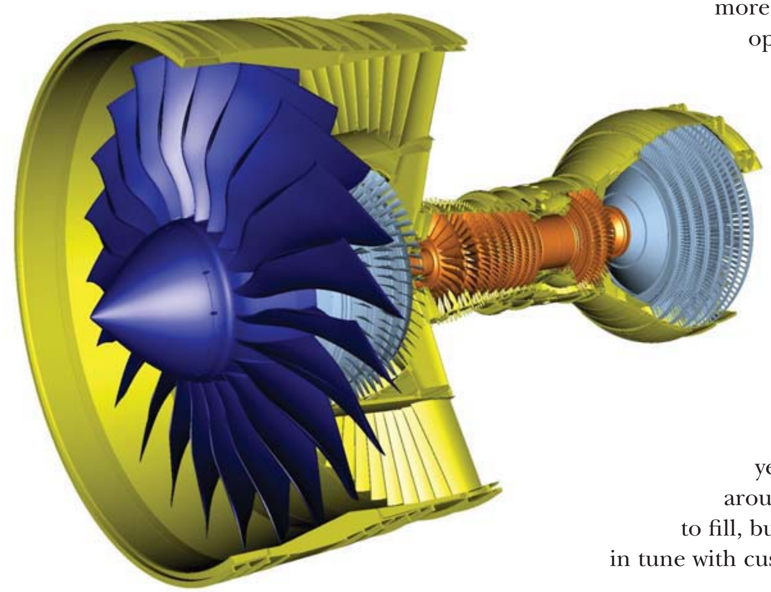
Boeing Selection *continued from page 1*



considerable investments over several years," said Calhoun. In fact, more than $1 billion has been invested in research and development annually for several years. Because of this aggressive R&D effort, the GENX will meet or exceed Boeing's performance targets. It will have dramatically lower emissions, thanks to a unique single-annular combustor. It will be low in weight, thanks to composite fan blades, which are unique to GE engines. And—most importantly—it will deliver outstanding fuel efficiency, thanks to technology derived from the engine with the highest pressure-ratio compressor in aviation, the GE90.®

Ultimately, the GENX engine will replace GE's highly successful CF6® engine family, a workhorse for commercial and military widebody aircraft for more than 30 years. Today, more than 5,000 CF6 engines are in service around the world. So the GENX engine has very large shoes to fill, but thanks to persistent research and development efforts in tune with customer needs, everything appears to be right on schedule.

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100 Million Hours and Counting…

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It's one of aviation's most successful jet engines, the GE CF6-80C2. And it's been powering widebody aircraft since 1985. Now, with more than 100 million hours of service under its belt, the CF6-80C2 is really showing its staying power.

And the engine shows no signs of slowing down. It has taken 18½ years for the engine's worldwide fleet to rack up 100 million hours of flight time. But, based on the engine fleet's current utilization rate, it'll go another 100 million flight hours in less than ten years—about half the time it took to reach the first 100 million mile mark.

"We are thrilled about the performance and staying power of the CF6-80C2," says Colleen Athans, general manager for the CF6 project. "The engine has demonstrated best-in-class reliability and cost of ownership for our global airline customers. We look forward to the next 100 million hours of distinguished performance."

The CF6-80C2 engine is one of the world's most reliable and utilized jet engines, powering the Airbus A300® and A310®, and Boeing's 767, 747® and MD-11® aircraft with more than 3,000 engines in service at 109 global airlines.

It's in the Genes

This achievement should come as no surprise from the most successful engine family in commercial aviation history. The CF6 engine family offers some of the best-selling commercial engines, powering more than 10 models of widebody aircraft. In recent years, the engine family has also played a major role in military aviation powering transports, tankers and surveillance aircraft. CF6 engines have flown more hours than any other high-bypass engine family.

Adding to HPT Blade Life

New CFM56-5B/-7B Repairs Extend Life Expectancy

One of the most significant contributors to engine overhaul maintenance costs is the replacement of non-repairable High Pressure Turbine (HPT) blades. GE strives to develop cost-reducing technologies and is now offering a new repair for the CFM56® fleet.

Two primary reasons HPT blades are scrapped include reduction of wall thickness and the corresponding loss of structural integrity, and cracking or loss of internal and/or external protective coatings. With approximately 2,000 CFM56 overhauls planned over the next four years, implementation of repairs to address these issues is vital to reducing an operator's cost of ownership.

Several repairs have been developed to extend the operating life of the CFM56-5B/P and -7B HPT blade:

1) A full repair replaces lost blade tip material and restores the blade to new-make dimensions. This repair also applies new airfoil coatings, including thermal barrier coatings.

2) A rejuvenation repair is similar to a full repair, but utilizes unique processes that remove thermal barrier coatings and prepares the airfoil for reapplication of new coatings. These processes have been developed to maintain blade wall thickness while adding new airfoil coatings.

3) A blade shank, internal-cavity coating removal repair also extends the life of the blade. This Service Bulletin repair (SB 72-0443 and 72-0389) is performed concurrently with a full or rejuvenation repair.

Development of a life-extending full repair is GE's latest innovation. Unique trailing edge cooling and weight-reducing wall thickness designs required engineers to develop new repair processes to preserve the structural integrity and cooling effectiveness of the blade.

With the development of revolutionary chemical stripping and masking processes, we are able to offer a full repair for the -5B/P and -7B HPT blade. This repair reduces cost of ownership by increasing blade repair yields and provides the opportunity for at least one additional operating use of the blade.

The GE-developed stripping process effectively removes the environmental coating while minimizing parent alloy material loss. Unlike conventional stripping processes, this new method can be utilized at room temperature and it's environmentally friendly. Development of a new masking technique was also required to preserve the extremely thin walls associated with the trailing edge cooling slots.

Engine operators will benefit in a number of ways. It allows repair of blades that previously would have been declared non-repairable and provides additional life, allowing the blade to remain operational until the next shop visit.

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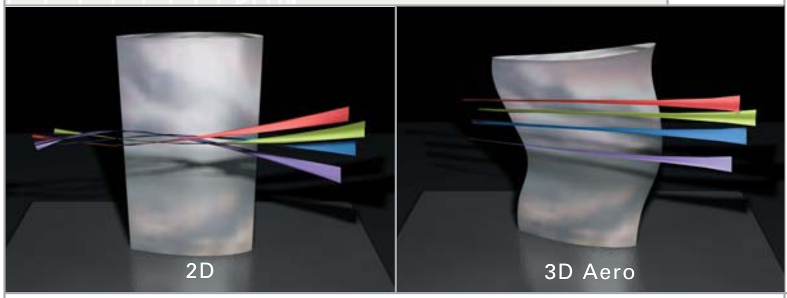
Thinking Outside the 2D Box

"3D Aero" is a design process where engineers use computational fluid dynamics to simulate and test airflow over jet engine parts in both compressors and turbines. As an example, the engineers would first create a "virtual" airfoil using an application that's similar to a highly-advanced CAD program. They then use the powerful software developed by GE engineers to test the design in different operating conditions. The application can even analyze designs at supersonic airflow velocities.

This iterative process allows GE to investigate several airfoils without having to build each. Once they find a design with promising predicted results, a true prototype is manufactured and moved into full component testing. Where planning, building and testing a turbine blade used to take years, 3D Aero designing can be achieved in weeks. 3D Aero-designed parts have been responsible for increasing EGT margins by 15-20 degrees Celsius on select engines, resulting in a measurably lower fuel burn for their operators.

Improved Airflow



No Need to Bite Off More Upgrade Than You Can Chew

CFM56-3 upgrades now offer options for how operators save

Since the CFM56-3 Upgrade Program went into effect in 2002, operators have enjoyed improvements of up to 2 percent better fuel burn and 23 degrees Celsius higher exhaust gas temperature margin (EGTM). Now, after additional testing and certification, CFM will begin offering an even more flexible and affordable way to upgrade: separate kits. These separate kits will give each operator the option of customizing the upgrade to meet their specific needs—higher EGTM or increased durability—both of which extend time on wing. There are two new upgrade kits available.

CFM56-3 Enhanced Performance (EP) Compressor:
This upgrade takes advantage of enhanced 3D Aero design. (see Factoid, pg. 3) The 3D airfoils replace the existing compressor airfoils and are priced the same as their 2D predecessor components. The best time to complete this upgrade is during a performance restoration shop visit, typically every 6,000-10,000 flight hours. At the visit, repairable 2D airfoils are removed and used later in follow-on engine shop visits, a valuable savings for operators. EP-upgraded engines are expected to see an additional 15-20 degrees Celsius of EGTM, which equates to longer time on wing. The improved efficiency of the HPC also results in a 1.1 percent improvement in fuel burn, which translates to between $8,000 and $12,000 per engine, per year fuel-burn savings, depending on flight leg and utilization.

CFM56-3 Low Scrap Rate (LSR) Turbine Blade:
This HPT blade sub-kit, or LSR kit, comes in a complete set of 72 turbine blades. The upgraded blades have a scrap rate of up to 50 percent less than the current configuration. The new blades are not interchangeable, and must be installed in complete sets, however the old blades can be removed and repaired for use in follow-on engines. The upgraded components can be installed in sets, at the pace of normal HPT blade consumption, keeping customers "cash neutral," while upgrading their fleets over time.

CFM is issuing Service Bulletins to add the EP and LSR kits to the field list of approved parts for all CFM56-3 models and will begin shipping the new parts immediately.

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The purpose of *Service Solutions* is to enhance communication with our customers. Please contact us if we at GE Engine Services can be of further service to you.

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