



Tech CF6 Program Upgrades CF6-80C2 Engines

Incorporation of Tech CF6™ upgrades will enable operators of CF6-80C2 engines to realize longer time on wing, fewer engine removals and lower maintenance and repair costs—all factors in lower cost of ownership and higher residual value.

In the 20 years since CF6-80C2 engines entered commercial service in 1985, they have compiled well over 100 million flight-hours while establishing an unsurpassed record of reliability.

Based on the engine fleet's current flying rate of more than 800,000 flight-hours per month, the engines will reach another 100 million flight-hours even sooner—in less than 10 years. In addition, the role of the CF6-80C2 has been expanded to include powering military aircraft: the Japan Defense Agency's next-generation cargo aircraft, Boeing E-767® AWACS (Airborne Warning and Control System) aircraft; the Italian Air Force's Boeing KC-767 tanker transports; and the U.S. Air Force's re-engined Lockheed Martin C-5® Galaxy.

"The engine has demonstrated excellent reliability and cost of ownership for our customers," said Colleen Athans, general manager of the CF6 Project. "Now, we are implementing the Tech CF6 Program to further improve the performance and reduce the maintenance costs of in-service engines."

GE sought input from customers as to improvements they would like to see. GE also analyzed feedback on engine performance and maintenance as well as operational data from the millions of flight-hours.



The cumulative result? The initiation of the Tech CF6 Program, with a \$15 million budget to develop, define and implement upgrades for the CF6-80C2 engine over the next two years. The program applies advanced materials and coatings technology and design techniques, much of it proven on other engines produced by GE and by joint ventures in which GE is a partner.

The upgrades—to the high-pressure compressor (HPC), high-pressure turbine (HPT) and combustor—will be provided as kits. The kits are scheduled to be available by late 2006/early 2007, following successful completion of rigorous validation testing.

The HPC durability kit includes new stage 1 blades that are resistant to foreign object

damage (FOD). Erosion coating being added to all stages of blades improves durability. Advanced, three-piece bushings on the variable stator vanes will reduce the incidence of unscheduled engine removals. Overall performance will be improved, and the number of HPC exposures will be reduced, as will maintenance costs. In addition, there is a specific fuel consumption (SFC) retention of up to 0.25 percent attributable to reduced leakage.

The HPT airfoil durability kit includes stage 1 blades with advanced tip cooling to reduce the scrap rate. A corrosion protection coating has been applied to the stage 2 blades. Ribs have been removed from the interior of the stage 1 nozzles to eliminate a potential crack initiation site and further reduce unscheduled engine removals. Custom inserts in the stage 2 nozzle will optimize cooling in order to minimize scrap. Finally, the next-generation N2 material of the shroud will require no heat-resistant coating.

The combustor durability kit will extend the life of the combustor liner through new cooling hole geometry in the inner and outer liners, which will distribute the temperature more evenly and reduce peak temperatures. Also, new splash plates manufactured from N2 material will be more durable than the MM509 splash plates they replace. Both the scrap rate and repairs of the upgraded combustor will be significantly reduced.

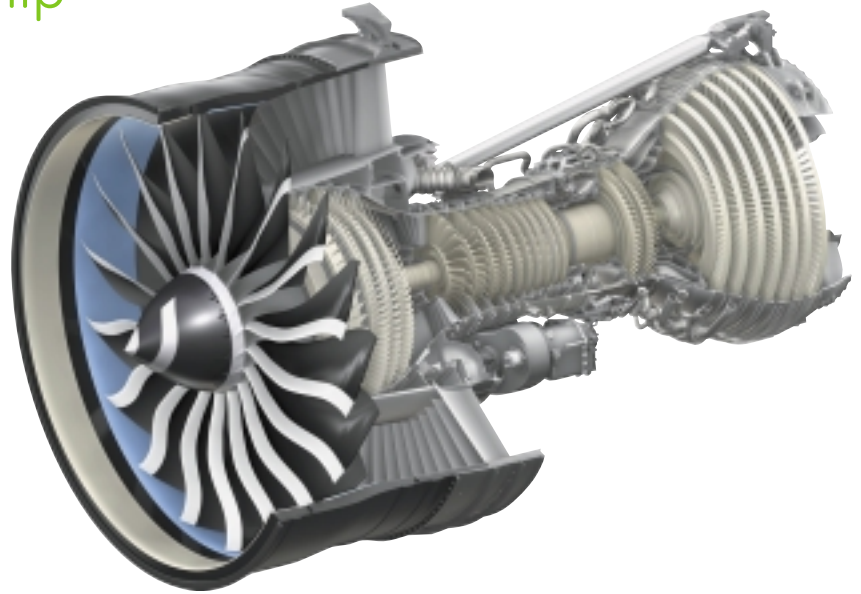
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GENx Advanced Technologies Increase Time on Wing, Lower Cost of Ownership

The incorporation of advanced technologies and next-generation materials into the GENx® has created a forward-looking engine that will significantly lower maintenance costs and overall cost of ownership compared with the GE engines it replaces.

“Time on wing is typically the single biggest driver in maintenance cost. We made it a requirement that the GENx stays on wing longer than the CF6®, which is already one of the industry’s most reliable engines,” said Fred Stadler, customer technical marketing leader, GENx Marketing. “The disciplined approach we are taking in the GENx development process ensures that every design decision is understood in terms of its impact on cost of ownership.”

The GENx advanced technologies start in the fan, where use of lightweight composites in both the fan blade and fan case make the front end of the engine virtually maintenance free. Composite materials are inherently more resistant to damage than traditional metal components, thus reducing the frequency of

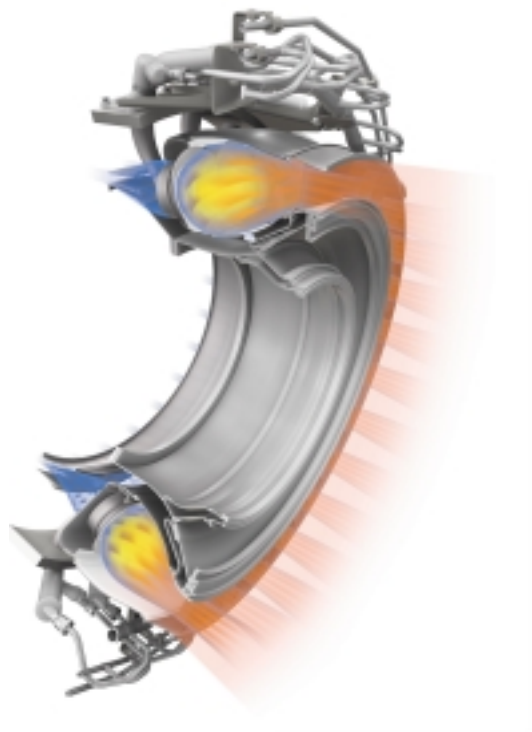


repairs. Composite blades have been in service for nearly a decade and 6.5 million engine flight-hours on the GE90®, over which time only three blades have been scrapped.

In the high-pressure compressor, use of bladed disks, or “blisks,” in three stages, combined with improved variable stator

bushing material, will result in the compressor being overhauled at every other shop visit. Because the GENx will incorporate proven GE90 foreign object damage (FOD) elimination features, customers will virtually never need to do work on the high-pressure compressor to repair FOD damage. The same features also significantly

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The GENx File

	Applications		
	787-3, -8, -9	747-8	A350-800, -900
Thrust	54-70K+	67K+	63-72K+
Fan diameter (inches)	111.1	104.2	111.1
Fan blade count	18	18	18
Bypass ratio (takeoff)	9	8	9
Overall pressure ratio (takeoff)	44	44	44
Compressor stages (fan/booster/HPC)	1/4/10	1/3/10	1/4/10
Turbine stages (HP/LP)	2/7	2/6	2/7
Entry into service	2008	2009	2010
<i>GENx engines for 787®, 747® and A350® share a common core (HPC, combustor and HPT).</i>			

Southwest Airlines Signs OnPoint Solutions Agreement with GE

Under the terms of a new eight-year OnPoint Solutions service agreement, GE will maintain Southwest Airlines' fleet of nearly 600 CFM56-7B engines, including those currently in service and those on order. This is the most recent of several maintenance agreements

struck between Southwest Airlines and GE over the past 10 years.

"More than half of our current fleet is powered by the CFM56-7B," said Jim Sokol, vice president of Maintenance and Engineering

for Southwest Airlines. "This new contract helps assure us that we're going to maximize our investment in this product and enables us to achieve the kind of engine maintenance cost savings that we need to remain profitable."

The agreement provides the airline price and program flexibility that will minimize risk and reduce cost of ownership. Features include fixed-price shop visits, turnaround time and performance guarantees, spare engine availability, on-wing support and remote diagnostics, plus fleet management support. Fleet management support makes available to Southwest Airlines GE's acknowledged expertise in engine work-scoping, shop visit forecasting, cost estimating and budgeting.

Founded in 1971 and based at Dallas, Texas, Southwest Airlines is the United States' largest domestic carrier in terms of passengers enplaned. Southwest currently operates more than 3,000 flights a day, serving 61 cities in 31 states.

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GENx Advanced Technologies . . . continued from page 2

minimize airfoil erosion, reducing the need to replace blades and vanes due to airfoil thinning.

The GENx will be the first production engine employing an innovative twin-annular premixing swirler (TAPS) combustor (illustration, page 2, at left). This technology was first demonstrated in the CFM56® TECH56™ program. Since then, GE has conducted two full-scale GENx TAPS combustor rig tests. In addition to meeting all the operability and emissions goals, TAPS produces a more uniform gas-stream temperature profile. As a result, the GENx is GE's cleanest-burning engine in its thrust class.

The high-pressure turbine (HPT) incorporates two stages of 3-dimensional aerodynamic

(3-D aero) blades that will be protected by next-generation thermal barrier coating. The coating will increase engine time on wing (compared with the GE engines it replaces) by reducing thermal distress as well as facilitating additional repair capability. Both the HPT blades and HPT nozzles are being designed for multiple engine runs, providing customers the option to repair versus replace at each shop visit.

As GENx development moves forward, design will continue to focus on ways to reduce weight, improve performance and lower cost of ownership. "One area where we're especially focused is engine weight," said Stadler. Three key areas—use of composites, blisks and lightweight turbine materials—have afforded

the GENx significant weight reductions over a more conventional design. "A lighter engine equates to less fuel consumption and more payload capability. Quite often, steps that are being taken to reduce weight also result in lowering cost of ownership, which is what we must continue to focus on to meet our customers' expectations."

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GE90 Fan Blade Receives 'Best of Show'

The GE90-115B composite fan blade was honored as Best of Show at the American Composites Manufacturers Association's Awards for Composites Excellence. The Best of Show award is given to the entry that exhibits excellence in design, engineering, manufacturing, market significance, creativity, process innovation and use of composite materials.

The first composite fan blade in commercial aviation, the GE90 blade was developed at GE's Evendale, Ohio, facility. Composite technology has allowed GE to create a uniquely curved blade design that is lighter, more aerodynamic and larger than traditional titanium blades. The lighter blades cause less stress on the system and enable other engine components to be lighter and smaller, reducing the weight of the engine and lowering fuel burn.

GE introduced the composite fan blade to commercial aviation on its first GE90 engine—the GE90-77B—when it entered service in November 1995. Those blades have performed remarkably well, powering Boeing 777®s with no routine on-wing maintenance required and no in-service issues for more than a decade. This fan blade technology is carried over and shared with the next-generation GENx engine.



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