



CFM 3-D Aero Providing Better Fuel Burn, Longer On-Wing Life

A continual investment in the CFM56* product line has yielded substantial customer benefits over the years. Between 1989 and 2005, in-flight shutdowns were reduced by 78%, aborted takeoffs by 80% and the fleet-wide dispatch reliability rate is now better than 99.96%.

CFM International (CFM) uses the benefits of advanced three-dimensional aerodynamic (3-D aero) technology to breathe new life into the mature CFM56-3 and CFM56-5C fleets, providing customers with significant benefits and extending the useable life of assets.

CFM56-3 Advanced Upgrade

The CFM56-3 Advanced Upgrade incorporates 3-D aero high-pressure compressor (HPC) blades and new high-pressure turbine (HPT) hardware.

The upgrade is installed during normal overhaul. It provides up to a 1.6% improvement in specific fuel consumption (which directly impacts aircraft fuel burn) as well as up to 20°C additional exhaust gas temperature (EGT) margin, resulting in longer on-wing life and, thus, lower maintenance costs. Turbine improvements include new nozzle and shroud materials, a new blade coating and improved cooling. These changes lower scrap rates and repair costs in the turbine section by as much as 50%.

Overall, the upgrade can improve post-overhaul time on wing by up to 2,000 cycles.

Additional options: To help ensure flexibility in managing maintenance costs, CFM offers additional CFM56-3 kit options. The *Enhanced Performance Kit* includes the 3-D aero HPC blades and vanes for better EGT margin. The *Enhanced Durability Turbine Kit* reduces the HPT blade scrap rate by as much as 50%, thus reducing maintenance costs.

CFM56-5C Upgrade to CFM56-5C/P

The CFM56-5C/P upgrade kit incorporates advanced 3-D aero technology in the HPC and HPT design. Additional improvements have also been incorporated into the HPT to enhance durability. Overall, the CFM56-5C/P upgrade kit provides operators a 1% improvement in specific fuel consumption and up to an 18°C improvement in EGT margin. This translates to as much as 10% lower maintenance costs and up to 5,000 additional hours on wing.

Upgraded engines are fully interchangeable and intermixable with current engines and are virtually transparent in the cockpit.

3-D Aero Efficiencies

A significant advancement in computer capabilities, 3-D aero design helps to establish a more optimum contour of an engine airfoil to provide greatly improved efficiency. CFM initially



The blade at left was designed using traditional 2-D aerodynamic design techniques; at right is a 3-D aero blade.

used this technology in developing the advanced CFM56-5B and CFM56-7B engines. Today, CFM has more experience with 3-D aero than any other manufacturer, with these fleets logging a combined total of more than 80 million engine flight-hours of highly reliable service with airlines around the globe.

Contact: **Bob Barton** bob.barton@ge.com



OnPoint Solutions' First-Year Success Continues

The OnPoint* Solutions program was launched at last year's Paris Air Show by **AirAsia**, which entered into a 20-year agreement for the maintenance, repair and overhaul of the CFM56-5B engines of its new Airbus A320* aircraft.

Since then, the international popularity of OnPoint Solutions has increased steadily.

TAP Portugal, the national airline of Portugal, signed a nine-year OnPoint Solutions agreement covering maintenance, repair and overhaul of the CF6-80E1 engines that power its fleet of Airbus A330* aircraft. TAP Portugal, which celebrated its 60th anniversary this year, currently flies to 43 destinations within 25 countries in Africa and North and South America.

Cathay Pacific Airways signed a 20-year agreement for the GE90-115B engines of its fleet of Boeing 777-300ER* aircraft, the first of which is to enter service in September 2007. The agreement also provides for coverage of the GE90-115B engines powering additional aircraft acquired through 2017. Cathay Pacific Airways is an international airline based in Hong Kong, offering scheduled cargo and passenger service to more than 90 destinations around the world.

AMC Airlines, the charter carrier based in Cairo, Egypt, signed a 10-year OnPoint Solutions agreement for the CFM56-7B engines of the 737-800* aircraft in its fleet. In addition to charter flights between Europe and Egypt's tourist destinations, AMC Airlines offers tailored charters, domestic flights, VIP flights and long- and short-term wet leases.

Emirates has signed a 10-year OnPoint Solutions agreement for the maintenance and overhaul of the GENx* engines that will power 10 new Boeing 747-8* Freighters, which are scheduled to begin delivery in 2010. Launched in 1985, Emirates is the international airline of the United Arab Emirates. The company has evolved into a travel and tourism conglomerate comprising an award-winning commercial carrier, an international cargo division, a destination management and leisure division, an international ground-handler and an airline IT developer. From its base at Dubai International

Airport, Emirates currently serves destinations in nearly 60 nations on five continents.

China Cargo Airlines has signed a 15-year OnPoint Solutions agreement for overhaul and maintenance of the CF6-80C2 engines of its two Boeing 747-400ER* Freighters. The first all-cargo airline in the People's Republic of China, China Cargo provides scheduled domestic service, plus international service to destinations in Europe and the United States. China Cargo operates from two Shanghai airports: its main base at Hongqiao International Airport and a hub at Pudong International Airport.

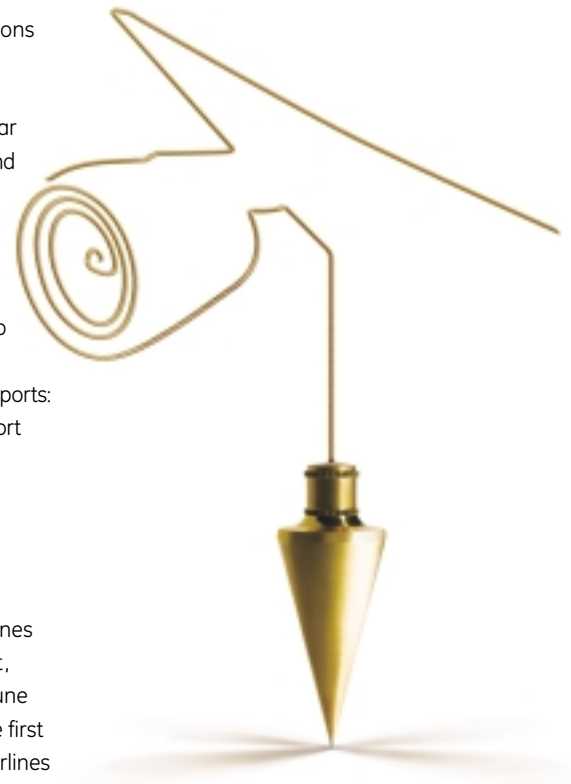
Increasing Popularity With New Engine Sales

Shanghai Airlines signed a 15-year maintenance agreement for the GENx engines of its nine Boeing 787* Dreamliner* aircraft, which are scheduled to begin delivery in June 2008. Since its establishment in 1985 as the first limited-liability airline in China, Shanghai Airlines has grown into a large enterprise group with air transport as its major business. The airline, which serves domestic, regional and international markets, will deploy the 787s in expanding its international routes.

In addition, three other major airlines in the People's Republic of China have signed memorandums of understanding (MOUs) that include OnPoint Solutions agreements.

China Southern Airlines' OnPoint Solutions agreement is for the GENx engines of Boeing 787 Dreamliner aircraft scheduled for delivery to begin in 2008. China Southern operates the largest airline fleet, as well as the most extensive domestic air network, in the People's Republic of China. In addition to its flight operations based at Guangzhou, China Southern has 13 branches within China and 38 international offices in major metropolitan markets around the world.

In September, **Hainan Airlines** signed an MOU that includes OnPoint services coverage of the GENx engines of the Boeing 787 Dreamliner aircraft it is to begin flying in 2008. Hainan Airlines is China's fourth-largest airline based on fleet size. The airline is headquartered in Haikou,



the capital of the island province of Hainan, which is located off China's southern coast. Hainan Airlines, which serves a scheduled domestic network, has begun to add international services.

An MOU for a 15-year OnPoint Solutions maintenance agreement will cover the GENx engines of 15 Boeing 787 Dreamliner aircraft of **China Eastern Airlines**. Already the largest GE/CFM International customer in China, China Eastern plans to initiate 787 service in 2008 on its expanding international routes.

"OnPoint Solutions are about flexibility, quality performance, increased productivity and strong customer support when and where our customers need it," says Brad Mottier, vice president and general manager of GE - Aviation, Services. "In implementing OnPoint Solutions, we tailor our services to meet each customer's specific needs. The response of our customers during the brief time that the OnPoint program has been available demonstrates that they prefer our new approach and recognize the value that GE brings to their business."

Contact: **Angela Jarczyk** angela.jarczyk@ge.com

New OnPoint Product Optimizes Workscope, Saves Money

Joint Specification Overhaul—one of GE's newer OnPoint* products—enables customers to work with GE to reduce overhaul costs and to meet their engine performance and time on wing (TOW) requirements. Introduced scarcely a year ago, Joint Specification Overhaul has already attracted more than 100 customers.

"Joint Specification Overhaul is a highly effective program that has universal application," says Jacques Chausse, general manager of Services Marketing. "So far, it has been especially attractive to customers who have a short ownership horizon."

In developing a Joint Specification Overhaul agreement with the customer, GE shares its broad experience and technical expertise as the engine OEM (original equipment manufacturer) to jointly define an overhaul workscope that serves to minimize cost while meeting critical customer performance requirements in areas

such as TOW and turnaround time. GE provides value through:

- Reducing engine module exposure and repair, while still meeting customer requirements;
- Matching life-limited parts (LLPs) build, including an optional provision for GE to buy back specified LLPs; and
- Making recommendations on modular repair levels.

An important aspect of the program is the customer's option to reduce overhaul costs by employing used serviceable material, including LLPs. Based on the customer's objectives and the engine operating profile, GE proposes an overhaul package that is customized to substantially reduce costs, including the use of a specified percentage of used serviceable materials and used LLPs, consistent with accomplishing the desired TOW. The used serviceable materials



are of the highest quality, and the LLPs come with back-to-birth traceability.

"Joint Specification Overhaul is a particularly effective approach that enables each customer to realize a satisfactory rate of return—in the form of exceptional value, reliability and quality—on its overhaul investment," says Chausse.

Contact: **Jacques Chausse** jacques.chausse@ge.com



GE - Aviation has opened a new China Operations Center (CHOC) in Shanghai to provide dedicated customer and product support for the country's growing aviation market. The center officially began 24-hour, seven-day-a-week operations in August.

"There are more than 1,600 GE and CFM56* engines in service in China. With the opening of the China Operations Center, we now support that fleet locally," says Tony Aiello, general manager of Customer and Product Support for GE - Aviation. "The center

GE - Aviation Launches New Customer Support Center in China

is staffed by highly trained Chinese nationals who bring a wealth of technical expertise to the role and eliminate any potential language barriers. We're offering a menu of services, including OnPoint* Diagnostics, that translates to a 'one-stop shop' and even better support for our customers."

The CHOC supports all GE and CFM56 engine models. In addition to technical line and shop maintenance support, the CHOC provides expanded services such as in-country technical and AOG (aircraft on the ground) spare part support, lease engine dispatch and fleet data management, as well as enhanced support for smaller operators. The center integrates engine diagnostics (health monitoring) with the product

support elements to develop proactive solutions to fleet issues.

"This new center is a logical extension of GE's support of our customers in China," says Mike Wilking, president, China Region, for GE - Aviation. "Coupled with the Spare Parts Service Center in Beijing, the Aero Engine Maintenance Training Center in Guanghan City and the On Wing Support operations in Xiamen, GE is providing a comprehensive package that will help our customers continue to succeed in an increasingly competitive and dynamic industry."

Contact: **Jeff Milam** jeffrey.milam@ge.com

Productivity Investments at GE Engine Services Malaysia

GE is investing \$5 million to increase productivity at the GE Engine Services Malaysia (GEESM) maintenance, overhaul and repair facility at the Malaysia International Aerospace Centre in Subang.

GEESM is a joint venture of GE, Malaysia Airlines and AirAsia.

Already the largest overhaul service provider for CFM56-3 engines in the Asia Pacific region, GEESM is preparing to add overhaul and repair of CFM56-5 and -7 engines entering service with airlines in the region.

In the first year of increased productivity, the number of engines overhauled is expected to rise from 125 to 150. Ultimately, more than 165 overhauled engines will be returned to service annually—a 35% increase.

“The physical size of the shop will not be increased,” says Doug McLean, managing director of GEESM. “The improvement will be

entirely attributable to streamlining processes and procedures, reorganizing the layout of the shop floor and, most important, introducing a new gantry system in the revamped CFM56* overhaul area.”

The gantry system enables the implementation of a “first in, first out” flow sequence, based on assigned stations for the removal and installation of engine components.

If a removed component is unserviceable, but within repairable limits, it is repaired at one of GE - Aviation, Services’ component repair facilities. If it exceeds repairable limits, it is scrapped and replaced with a new or overhauled component.

GEESM, which currently provides maintenance, repair and overhaul services for more than 35 airlines in Asia, is now well-positioned to expand its customer base



without compromising its reputation for world-class quality.

“We are making every effort to provide our customers with reliable engines, in the least turnaround time, at the most competitive price,” says McLean.

Contact: **Doug McLean** douglas.mclean@ge.com

THE AMERICAS

Kevin McAllister
kevin.mcallister@ge.com

EUROPE

Jack Lutze
jack.lutze@ge.com

ASIA

Chaker Chahrour
chaker.chahrour@ge.com

CHINA

Mike Wilking
mike.wilking@ge.com


MIDDLE EAST

Muhammad Al-Lamadani
muhammad.al-lamadani@ge.com

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GE
Aviation

General Electric Company
One Neumann Way
Mail Drop J4
Cincinnati, OH 45215 U.S.A.
Phone: +1.513.552.3272 (Internationally)
+1.877.432.3272 (Within U.S.)
Fax: +1.513.552.3329
www.geaviation.com/onpoint
E-mail: servicesolutions@ge.com

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