THE POWER TO GO FURTHER

GE Aviation's GE38 may have its roots in the 1980s, but the manufacturer sees a wealth of opportunities for the new powerplant above and beyond Sikorsky's CH-53K

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Sometime in November Sikorsky will fire up the three engines on the first, partially assembled CH-53K heavy lift helicopter.

The event is termed a "barehead light-off" – so-called because the seven-blade main rotor is not installed. A powered light-off is scheduled by the end of February, with first flight following later in 2014.

All eyes during each of the three milestone events will no doubt rest on the bulky airframe of the CH-53K – the second-largest helicopter in the world by weight, behind the Mil Mi-26. But a sharp eye should focus on the technology that made the CH-53K possible: the 7,500shp (5,600kW)-class GE Aviation GE38-1B turboshaft engine.

As the first new centerline turboshaft engine to enter the US military inventory in almost a decade, the arrival of the GE38 in flight testing next year could have implications beyond the CH-53K programme.

An available new aircraft engine often serves to stimulate demand for more – and more fuel efficient – power.

The US Navy has already considered the GE38 for maritime propulsion applications. The US Marine Corps once flirted with the idea of replacing the Rolls-Royce AE1107C engine on the Bell-Boeing MV-22 with GE's newer and more powerful alternative. GE's own strategy for the GE38 is even more comprehensive. The company sees re-engining possibilities on a variety of military aircraft, including the Lockheed Martin C-130, Northrop Grumman E-2C Hawkeye and Boeing CH-47 Chinook. It is also ready to compete against a new Pratt & Whitney Canada turboprop engine in the commercial market, with ATR and Bombardier still debating whether to launch a 90-seat turboprop.

GE

The engine will enter flight trials next year

"We are literally talking with all the airframers about applications for the engine," says Harry Nahatis, GE's general manager for advanced turboshaft and turboprop programmes. "Anything in that power class is a potential." Of course there are no guarantees in the aircraft engine business, and the GE38 is a prime example.

The CH-53K powerplant is a descendant of a technology demonstrator for a turboshaft engine – the GE27 – which the US Department of Defense funded in the mid-1980s.

The GE27 set a record for fuel consumption, power-to-weight ratio and horsepower to airflow-specific power, Nahatis recalls. However, it was not picked up for a production programme.

COST OVERRUNS

An opportunity to replace the Lockheed P-3 fleet with a new turboprop in the late 1980s came next.

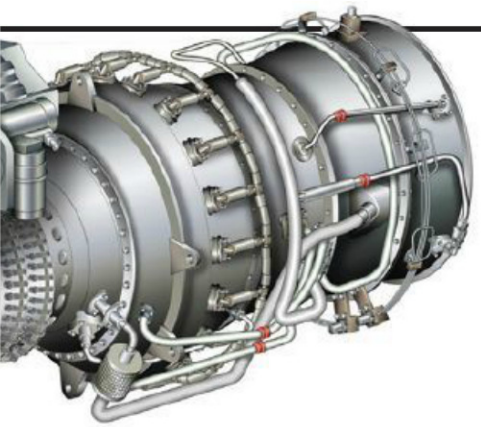
GE adapted the core of the GE27 into the T407 turboprop and was selected to power the P-7, beating a rival bid based on a variant of the R-R AE1107C, the AE2100. GE accumulated about 1,000h of ground test data on the T407 before cost overruns on the airframe prompted the navy to cancel the P-7 in 1990.

Although launched as a military programme, the GE27 core finally gained traction as a commercial turbofan engine. The core formed GE's contribution to the CFE738, produced in partnership with Honeywell for the Dassault Falcon 2000 business jet in the late 1980s. However, GE still had a valuable asset with the original turboshaft core engine. Among Western engines in production, the only alternatives in the same thrust class as what became the GE38 are the AE1107C and the Pratt & Whitney Canada PW150.

All three engines competed to power the CH-53K – a unique propulsion challenge.

Cleverly bypassing a potentially messy competitive acquisition process, the USMC decided to replace the CH-53E Super Stallion – powered by the 4,750shp GE T64 – with a so-called "derivative" airframe. However, while the CH-53K may technically be a derivative, it requires Sikorsky to integrate an all-

Replacing the CH-53E with a "derivative" has streamlined the acquisition process



GE

The powerplant is in the 7,500shp class

new cabin, cockpit, rotor system, engine and drivetrain. It shares only a similar silhouette with its predecessor.

Finding the right propulsion system was especially important for the CH-53K. The CH-53E is limited to lifting about 3,630kg (8,000lb) externally at 33°C (91°F) for about 110nm (204km). The CH-53K is designed to sling-load 12,200kg over the same distance in the same weather.

Lifting such a load requires a robust rotor system and a very powerful engine. Sikorsky selected GE's proposal based on the GE27 core, with a new designation – the GE38-1B.

The CH-53K engine emerged as a five-stage axial compressor coupled with a single-stage centrifugal compressor, annular combustor, two-stage gas generator turbine and three-stage power turbine.

"We took that [GE27] core and then we made some adaptations. We adapted it for the rotorcraft environment," Nahatis says.

FAMILIAR TERRITORY

GE is familiar with helicopter operations, with a stable of turboshaft engines that include the T700 and T58.

"We know the harsh sand and hot-high and corrosive salt environments – the engine needs to withstand all those," Nahatis says. "We made some changes to the engine to address those things to adapt it to the helicopter environment, and that's how we arrived at the GE38."

Afghanistan and Iraq have forced the US military to learn hard-won lessons about how to operate helicopters in sandy and dusty environments. Sand, in particular, caused older engines like the T64 severe maintenance headaches. As a result, GE incorporated technology that "ruggedized" the airfoils of the GE38 without compromising efficiency. Anti-erosion coatings are also applied to the compressor to retain maximum performance over long periods.

The threat of sand also prompted GE to adapt the cooling system for the GE38. Each turbine blade is dotted with tiny holes used to cool the outer surface, preventing the metal from melting from contact with the exhaust gases exiting the combustor.

To prevent sand from plugging those crucial holes, GE redesigned the entire cooling air circuit in the turbine.

"You have to get the cooling effectiveness, but yet at the same time reduce its susceptibility to plugging," Nahatis says.

CUTTING-EDGE

At least two generations of materials technology have come into service with aircraft engines since the GE27 was demonstrated in the mid-1980s. GE is at the forefront of developing new materials. The GE9X turbofan for the Boeing 777X will feature a silicon-carbide form of ceramic matrix composites (CMCs) in the turbine and combustor, while the Passport 20 turbofan for the Bombardier Global 7000 and 8000 business jets will use an oxide-oxide form of CMCs in the engine's mixer.

There are no CMCs or other exotic materials present in the GE38-1B, however.

"We purposely did not inject brand new technology into the engine because we knew the appetite for risk on these programmes is not very high," Nahatis says. The GE38-1B, however, establishes a new baseline for turboshaft and turboprop performance in the power class of 5,000-10,000shp engines.

In November 2011, the army awarded GE a contract titled future affordable technology engine (FATE). The contract's goal is to develop a new engine in the 7,000shp engine class that reduces specific fuel consumption by 35% while improving shaft horsepower-to-weight by 80%, compared with engines in the inventory in 2000. It's not clear if GE intends to develop an all-new centerline engine or improve the GE38-1B. But the company has declared that the hot section and cooling technologies derived from FATE can be inserted into the CH-53K engines.

Aircraft manufacturers have already taken notice. Bell Helicopter is developing a next-generation tiltrotor as a successor to the AE1107C-powered V-22 – the V-280 Valor. In October, Bell selected GE over R-R to power the new aircraft, which is being proposed for the army's emerging joint multi-role programme. "We're talking to virtually all the OEMs," Nahatis says, "and there is quite a bit of interest." ■

US Air Force

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