The CF6-80E1

Maurick Groeneveld, Director Aircraft Management at Doric, reviews the highest thrust member in the CF6 engine series

With the CF6-80E1, General Electric specifically designed an engine for the Airbus A330. The first flight of a CF6-80E1-powered A330 was in November 1992 with the first delivery in December 1993 to Air Inter. The other engine options for the A330 are the Pratt & Whitney PW4000 (100 inch) engine series and the Rolls Royce Trent 700 engine series, which entered commercial service in 1994 and 1995, respectively. The CF6-80E1A2 became the base line version with a thrust rating of 67,500 lb and in subsequent years, higher and specific thrust versions followed with the –A3, the –A4 and the –A4/B. These versions are interchangeable between the -200 and -300 airframes of the Airbus A330.

FLEET

With a fleet of some 240 CF6-80E1-powered A330s in existence, the number of installed CF6-80E1s is about 480 engines and the total number of CF-6-80E1 engines (covering both installed and spare engines) is about 550. The major CF6-80E1-powered A330 operators include Air France, Alitalia, EVA Air, KLM, Qantas and Qatar Airways, with KLM, Qantas and Qatar Airways operating the CF6-80E1 engines on both the A330-200s and -300s in their fleet. The entire fleet of CF6-80E1 engines has accumulated about 13.7 million engine flight hours and about 2.9 million engine flight cycles. The aggregate number of engine flight hours of the global fleet of the CF6-80E1 engines presently increases with about 1.8 million engine flight hours per annum. The average flight duration

CF6-80E1 CHARACTERISTICS	
Fan	1 stage
LPC	4 stages
HPC	14 stages
Combustor	Annular combustion chamber
HPT	2 stages
LPT	5 stages
Fan diameter (inches)	114
Length (inches)	168
Dry weight (lb)	11,225

for the CF6-80E1 engines has slowly increased and is currently about 5 engine flight hours per flight.

VERSIONS

As mentioned above, there are four versions for the CF6-80E1 engines powering the A330s that are in service. These four versions have common hardware, are fully interchangeable between the A330-200s and the A330-300s and offer three different thrust levels by changing the rating plug and data plate. The -80E1A2 has a thrust level of 67,500 lb and is for slightly shorter range operation. The -80E1A3 has a thrust level of 72,000 lb and is aimed at hot or high/short runways operation. The -80E1A4 is aimed at medium to long runways and has a thrust level of 70,000 lb. The -80E1A4/B also has a normal thrust level of 70,000 lb, but offers a thrust bump to 72,000 lb. This -80E1A4/B version enables operators to make use of the extra thrust when needed whilst also benefitting from the longer time on wing of the -80E1A4 (and lower maintenance costs) as in actual experience the usage of the higher thrust is very limited.

OPERATIONAL EXPERIENCE

Apart from HPT stage 1 blade issues , the CF6-80E1 engines are currently not affected by any other big issues. This also means that, leaving the HPT stage 1 issues aside, the CF6-80E1 engine shop visits are currently primarily driven by the requirement for performance restorations.

HPT STAGE 1 BLADE ISSUES

It can be estimated that over a third of the recently performed CF6-80E1 shop visits were caused or linked with HPT stage 1 blade issues. These shop visits were either done following a proactive removal of the HPT stage 1 blades or following HPT stage 1 blade airfoil (oxidation) distress or HPT stage 1 blade separation. During the last the last five years a number of in-flight shut-downs occurred linked with HPT stage 1 blade issues. Needless to say that GE has been focused on this issue and its solution. The root cause is hot corrosion, which combines the influence of corrosive elements from the operational environment, the engine's temperature and accrued cycles and the material of the HPT blades offering the potential for cracking. In the meantime via SB 72-0478 an improved HPT stage 1 blade (part number 1639M70P20) is available for incorporation. This part number 1639M70P20 should solve the described issues as it features an improved chrome coating and an improved design aiming to reduce stress levels in the HPT stage 1 blades.

SHOP VISITS

The average time on-wing of the CF6-80E1 engines has improved over the last ten years. It can be estimated that the CF6-80E1 engines currently stay on-wing for about 4,000 engine cycles till the first shop visit. Obviously, this number is affected by the applicable thrust level of the engine as well as the flight length with longer flight lengths resulting in a lower figure for the engine's cycles on-wing and shorter flight lengths resulting in an even longer time on-wing in flight cycles. After the first shop visit

for performance restoration like for other engines, the time on wing till the next performance restoration is shorter than till the first shop visit and averages just over 2,500 engine flight cycles. This is significantly more than it used to be about ten years ago. The average time on-wing after the first shop visit is also affected by the flight length, but it looks that the achievable flight cycles deviates less from the average compared to the first run.

LIFE LIMITED PARTS MANAGEMENT

With the latest versions of the life limited parts in the CF6-80E1 engines having chapter 5 life limits of at least 15,000 cycles and the majority of the life limited parts having chapter 5 life limits of 20,000 cycles, replacement of life limited parts is normally not applicable in the early part of the engine's life. This contrasts with the life limited parts in the Trent 700 which features (significantly) lower life limits. Accordingly, the life limited parts management for the CF6-80E1 engines is relatively easy.

SUPPORT

There are three engine shops, which are certified for CF6-80E1 maintenance and repair. These shops are GE Caledonian in the United Kingdom, Air France Industries / KLM Maintenance & Engineering in Holland and Evergreen Aviation Technologies (EGAT) in Taiwan. Unlike with Rolls Royce's control of the Trent maintenance market (which would be applicable when having chosen for the Trent 700 on the A330), CF6-80E1 customers have the option to go to a non-OEM shop. At present, the number of CF6-80E1 shop visits is about 100 per annum, which is expected to gradually increase as the fleet is growing and engines mature. According to Doric's assessment, over 50 % of the CF6-80E1 engines are under long term dollar maintenance support agreements ("OnPoint solutions agreements") with General Electric, which is not only using its own engine shop but also the other non-GE shops to do the maintenance and repair of the engines.

The CF6-80E1 is a modern and reliable engine. Although there have been HPT stage 1 blade issues, it can be expected that the new blades will reduce these. High limits of the life limited parts make the life limited parts management fairly easy. With one GE engine shop and two non-OEM engine shops, CF6-80E1 operators have a choice where to send their engines for maintenance and repair.

Doric, with offices in Frankurt, London and New York, provides pro-active, hands-on asset management and remarketing services to owners, investors, financiers and operators of aircraft and engines. Aircraft and engines under long term asset management by Doric include aircraft like the Airbus A320 Family, the A330/ A340 Family, the A380 and the Boeing 777 and engines like the CFM56-5, the CF6-80E1, the GE90-115, the Trent 900 and the GP7200. Doric also performs asset management activities via project assignments with a more limited scope, such as aircraft inspections and technical records audits, remarketing of aircraft, aircraft redelivery support, and assisting with assessing, drafting and negotiation of contracts (for aircraft acquisition and technical support).