CFMI reveals more LEAP programme details

CFMI's LEAP family of engines has a bypass ratio as high as 12:1 achieved through a wide intake fan, and a core engine with a high pressure ratio and high combustion temperature. The engine also employs technologies to offset possible upward pressures on maintenance costs.

More details have emerged of CFMI's new LEAP engine family, including configuration of the three main engine series and some of the technologies used by the family to optimise its design.

The LEAP's three main series will be: the -1A, with several variants rated at 24,500-32,900lbs thrust to power the A320neo family; the -1B, with several variants rated at 20,000-28,000lbs thrust to power the three members of the 737 MAX family; and the -1C, rated at 28,000-30,000lbs to power the Comac C919 family.

The LEAP's architecture optimises the conventional two-shaft turbofan configuration. The engine's key design feature is the achievement of bypass ratios of between 10:1 and 12:1. This compares with the CFM56-5B's bypass ratios of 5.5-6.0:1, and the -7B's bypass ratios of 5.1-5.5:1. The -5B and -7B series have similar thrust ratings to the LEAP-1A and -1B.

These two LEAP series will have fan diameters of 78 and 69.4 inches, 9.7 inches and 8.4 inches wider than their respective CFM56 predecessors *(see table, this page)*.

In addition to wider intake fans, the LEAP family will achieve about double the bypass ratios of its predecessors by using a core engine that is physically narrower and has a higher pressure ratio. That is, the LEAP's core engine will have a pressure ratio of 20:1, compared to about 11:1 for the CFM56-5B and -7B. This will be achieved by the core compressing a smaller volume of air and burning fuel at a higher temperature than the CFM56.

These high bypass ratios and core engine pressure ratios will provide the LEAP family with a 15% lower specific fuel consumption (sfc) than the -5B/-7B.

The high bypass ratio and lower sfc is only possible, however, by optimising the conventional two-shaft turbofan configuration, and introducing some features that may compromise the overall cost of operation.

The key features that have been used are a dual-stage high pressure turbine (HPT), a higher combustion temperature, an additional stage in the high pressure compressor (HPC), and one or three more stages in the low pressure turbine (LPT) compared to the CFM56-5B/-7B.

The LEAP engines will therefore have an additional three or four core engine stages than the preceding engines powering the A320 and 737NG families. The LEAP's additional core stages will make the engine longer, and so possibly prone to more flexing. The additional stages also mean that the engine will use a larger number of life-limited parts (LLPs). Combined with the higher combustion temperatures, these features could all contribute to inflating the LEAP's maintenance costs compared to the CFM56-5B/-7B.

The LEAP has several design features to overcome these design issues.

The effect of the additional core stages and a narrower core could make the LEAP family more prone to flexing, and hence have a negative effect on its on-wing durability. CFMI has employed the use of two strong frames to counter flexing. These are the fan hub frame, and a new turbine centre frame. This is claimed to provide the LEAP with a stiffness that is superior to the CFM56's. The LEAP will also use innovative compressor case technology, which will further add to the core's stiffness and provide it with good rotating blade tip clearance management.

A key issue for maintenance costs is the high combustion temperature and use of a two-stage HPT. A high combustion temperature generally leads to a faster rate of HPT blade deterioration and so shorten removal intervals between shop visits. Despite this, CFMI says the LEAP family will be able to maintain a capability for similar exhaust gas temperature (EGT) margins through the use of next generation blade cooling and coatings. Moreover, the cooling passages in the HPT blades will be designed to ensure that the blade metal temperature is similar to the CFM56's HPT blades. It is not clear at this stage, however, what the LEAP's initial EGT margins will be.

CFMI will employ ceramic matrix composites for the first time, and will be used in the HPT shrouds. These composites can take higher temperatures than metal shrouds, and also provide additional strength. This will contribute to the HPT blades having a longer life.

The use of a second HPT stage, however, will also add pressure to engine maintenance costs. CFMI has used the twin annular premixing swirler (TAPS) combustor. This is intended to maintain uniform temperatures in the combustion chamber and the HPT, which CFMI claims will be beneficial to HPT maintenance costs.

The additional core engine stages will add to the number of LLPs over the CFM56. LLPs have high list prices, so they account for a high percentage of the engine's maintenance costs. CFMI claims the LEAP will have fewer LLPs than the competing Pratt & Whitney PW1000G. The LEAP's LLPs will have uniform lives of 20,000 engine flight cycles (EFCs) in the core, and 30,000EFC in the fan, LPC and LPT modules. LLPs will not have these lives at service entry, but they are expected to be extended to full target lives before they reach initial life limits based on fleet leader and in-service experience. AC

CFM56-5B/-7B & LEAP FAMILY ENGINE CONFIGURATIONS

Engine model	Thrust -lbs	Bypass ratio	Fan diameter	LPC stages	HPC stages	HPT stages	LPT stages
CFM56-5B	21,600-33,000	5.5-6.0:1	68.3-in	4	9	1	4
CFM56-7B	20,600-27,300	5.1-5.5:	61-in	3	9	1	4
LEAP-1A	24,500-32,900	Approx 12:1	78	3	10	2	7
LEAP-1B	20,000-28,000	Approx 10:1	69.4	3	10	2	5
LEAP-1C	28,000-30,000	Approx 12:1	78	3	10	2	7