LEAP of faith

CFM International's LEAP engine family promised impressive fuel efficiency and superior performance. But as the early units approach their first performance restoration shop visits, have they delivered on value, and can the MRO industry meet the demands of servicing these hugely sophisticated machines? Rob Munro reports.

Few will dispute that CFM International's LEAP (Leading Edge Aviation Propulsion) engine family has taken on the mantle of its hugely successful predecessor, the CFM56, in the single-aisle aircraft market.

The mighty LEAP clan now powers the Airbus A320neo family (LEAP-1A), the Boeing 737 MAX variants (LEAP-1B) and the COMAC C919 (LEAP-1C), although industry speculation suggests that, due to intellectual property concerns, the latter might be closer to an upgraded CFM56 than a clean sheet engine.

CFM International, a 50/50 joint venture between GE Aerospace and Safran Aircraft Engines, has delivered nearly 8,000 units and, with a backlog exceeding 10,000, the LEAP is now deeply embedded in the low-fare and regional aviation sector.

But the programme is at a critical inflection point, as the engines delivered earliest are approaching, or have already reached, the thresholds for performance restoration shop visits (PRSVs) in numbers far in excess of what was originally predicted when the engine was launched in 2008.

"We're forecasting LEAP shop visits to increase significantly by the end of this decade," Gaël Méheust, President and CEO of CFM International, said in April. "This is higher than our initial projections – driven in large part by the high demand for these engines."

In fact, the sheer volume of engines entering maintenance shops presents a significant logistical and technical undertaking for the global MRO network.

REAL WORLD VALUE

While no one doubts the engines' impressive fuel efficiency, their actual maintenance burden and operating costs are being re-evaluated as the units' inherent complexity and recognised in-service durability challenges of fuel nozzle carbonisation and

Wasim Akhtar, Director of Engines at AJW Group.
Photo: AJW Group

accelerated wear in harsh operating environments emerge as ongoing challenges.

The LEAP engine was marketed with the promise of maintaining the CFM56's legacy of reliability while delivering superior fuel efficiency. The explicit goal was to offer maintenance costs comparable to those of the CFM56 11, with promotional material promising expectations of "longer on-wing time".

Based on CFM56 benchmarks and typical narrowbody use rates of around 1,500 cycles per year, initial projections suggested that the first LEAP shop visits might not become widespread until engines reached 10,000 or more cycles, potentially translating to seven to 10 years of service before major overhaul intervention.

However, while the LEAP fleet achieved impressive dispatch reliability rates, the in-service issues led to higher than anticipated maintenance burdens and, in some cases, earlier than ideal engine removals for performance restoration or specific component replacements.

CFM's proactive development and deployment of hardware fixes, such as the Reverse Bleed System (RBS) for fuel nozzles and improved High-Pressure Turbine (HPT) blades, implicitly acknowledge that initial durability targets were not universally met, particularly under certain operating conditions.

Anca Mihalache, Managing Director at Aero Care, which provides aftermarket services and support to the narrowbody commercial aviation industry, believes the initial enthusiasm for the LEAP family may be wearing off.

"Initially, lessors were excited about the LEAP engine for its promise of improved fuel efficiency and lower emissions," she tells *LARA*.

"However, at Aero Care we have observed that as more LEAP engines reach mid-life, investors are taking a closer look at the long-term cost implications, especially for maintenance reserves, performance restoration shop visits, and LLP (life limited parts) replacement.

"Early expectations leaned toward longer intervals and lower overall maintenance costs. But the updated real-world data shows that while intervals are holding up, shop visit costs, especially those involving LLPs, are significant. As a result, lessors are adjusting maintenance reserve assumptions to better reflect actual cost trends over the engine life cycle."

MAINTENANCE BOTTLENECKS

The clustered arrival of engines for their first shop visits creates potential for significant bottlenecks if the MRO network's expansion lags behind demand.

CFM's ongoing efforts to expand its branded network reflect an awareness of this pressure and the need to ensure sufficient global support capacity.

Wasim Akhtar, Director of Engines at AJW Group, believes that, from an airline perspective, it is wise to secure long-term repair agreements – either directly with CFM or through third-party independent MROs licensed by the OEM.

He says: "These agreements allow for better planning and cost control around quick-turn and extensive maintenance events, which are expected to increase significantly in the coming years.

"Suppliers like AJW have been investing in acquiring aircraft powered by LEAP engines. This strategic move ensures access to critical components and allows for timely support to both airlines and MROs as demand for spare parts intensifies."

Akhtar feels that it is as yet too early to accurately predict the true total cost of ownership (TCO) of a LEAP engine.

"As far as evaluating actual operational and maintenance costs go, several key factors will come into play – including engine reliability, the frequency of maintenance events, availability of USM (used serviceable material), and the overall efficiency of the MRO network.

"Ultimately, determining whether the LEAP engine meets its cost-effectiveness expectations compared to the CFM56 will depend on the quality and transparency of operational data across the industry. A clear

CFM's LEAP MRO network strategy

CFM has structured its LEAP MRO network into three tiers:

OEM shops: GE and Safran (CFM's parent companies) have their own repair shops (eight globally for CFM). These handle early support, warranty work, complex fixes needing their expertise, and developing new repairs. They also set the standard for quality and speed.

CFM branded service agreements (CBSA): CFM licenses some trusted third-party repair companies (like StandardAero, MTU Maintenance, and Lufthansa Technik). These get access to CFM's technical information, tools and training if they meet CFM's quality and invest in LEAP capabilities.

Open network/non-CBSA shops: CFM calls this its "open MRO ecosystem", meaning that independent MROs not holding a CBSA can perform some work on LEAP engines.

picture of the true cost of ownership is unlikely to emerge for at least another decade."

GOLD STANDARD

The CFM56 engine became a gold standard for time-on-wing, or TOW. Over its lifespan, the engine's reliability continuously improved. By the mid-1990s, it was common for a CFM56 to fly over 12,300 hours and 9,100 flights before its first shop visit.

Newer versions did even better, reaching over 14,000 hours and 10,000 flights, with some approaching 30,000 hours before needing a major overhaul.

However, comparing the LEAP's performance to the CFM56's numbers, achieved after many years of improvements, isn't entirely fair.

When CFM said "similar maintenance costs" they probably meant the average cost over the engine's entire lifetime, not that the LEAP would go just as long without maintenance from the very beginning.

Add the growing availability of cheaper parts to the mix and it is likely that the TCO of LEAP engines will reduce over time.

Anca Mihalache, Managing Director at Aero Care.
Photo: Aero Care

"This evolution is not unusual with newer technology," says Anca Mihalache. "Aero Care believes that a very important aspect is the emerging spare parts market for the LEAP engine, which is showing as expected signs of growth.

"As more engines reach maturity and part-out activity increases, lessors and operators alike will benefit from greater availability of used serviceable materials, easing long-term cost pressures. This will also support more flexible maintenance planning and stronger asset liquidity."

THE MRO CHALLENGE

Advanced materials, higher operating pressures and temperatures, and sophisticated combustion systems are key to the LEAP's 15 to 20 per cent fuel burn reduction compared to the CFM56.

However, materials like Ceramic Matrix Composites demand new repair techniques, specialised tooling, and potentially lead to higher initial scrap rates as the industry navigates the learning curve.

This inherent tension between operational efficiency and maintenance complexity is fundamental to assessing the LEAP's true life cycle cost and the readiness of the MRO sector.

Wasim Akhtar says: "MRO providers, both in the UK and globally, have been proactively preparing for this surge. Many have invested heavily in infrastructure, tooling, and staff training to ensure they are equipped for the expected wave of LEAP engine maintenance, particularly beyond 2028. By that time, the LEAP engine fleet is projected to surpass the size of the legacy CFM56 fleet."

Lufthansa Technik, a CFM Premier MRO partner, holds the distinction of being the first independent MRO provider authorised by CFM to offer comprehensive services for both LEAP-1A and LEAP-1B engines.

The company has already completed more than 70 LEAP engine maintenance events, including the first LEAP-1A performance restoration shop visit.

The LEAP advantage

The LEAP engine family represents a significant technological evolution from its CFM56 predecessor, achieving step-change improvements in fuel efficiency, emissions and noise.

Key advances

Materials:
- 3D woven carbon fibre fan blades and case (Resin Transfer Moulding).
- Components made using Ceramic Matrix Composites (CMCs) allow hotter, more efficient operation.
- Titanium Aluminide (TiAl) in low-pressure turbine produces lighter blades.

Architecture and aerodynamics:
- Higher bypass ratio means greater fuel efficiency and less noise.
- Higher overall pressure ratio produces greater thermal efficiency.
- Advanced 3D Aerodynamics optimise airflow for efficiency.

Combustion:
- TAPS II Combustor: Pre-mixes fuel and air for cleaner, cooler burn, reducing NOx.

Additive manufacturing:
- 3D-Printed Fuel Nozzles: Complex design for optimised fuel delivery, lighter and potentially more durable.

Debris rejection system:
- Centrifugal separation ejects debris to protect the engine core, improving durability in harsh environments.

Source: CFM International

To support this growing activity, Lufthansa Technik is expanding its operational capabilities and strengthening its local footprint.

A company spokesperson says: "Lufthansa Technik will establish a new engine repair station in Calgary, Canada, dedicated to servicing LEAP-1B engines for near-wing and quick-turn work. The facility will feature a modern test cell, the first of its kind in Canada, for next-generation engines. Operations are set to begin in 2027, with WestJet as the launch customer."

Lufthansa Technik's Mobile Engine Services station in Dublin also recently received approval from the German Federal Aviation Office for maintenance services under EASA/FAA certification for LEAP-1A engines.

"To be able to perform these services on LEAP engines and continuously develop the repairs, we work very closely with CFM International," the spokesperson added.

A TESTAMENT TO TECHNOLOGY

The CFM LEAP engine stands as a testament to technological advances in aero-propulsion, delivering remarkable fuel efficiency gains.

However, such progress has brought with it significant maintenance complexities and initial durability challenges that have both tested the MRO industry and lowered the engine's early TCO performance when measured against lofty expectations.

While CFM is actively addressing the known issues and the MRO network is rapidly adapting, the journey towards achieving mature, cost-effective life cycle support for the LEAP fleet is ongoing.

The ability of both the manufacturer and the MRO industry to continue innovating and optimising maintenance strategies will be crucial in fully realising the long-term economic potential of this pivotal engine programme.

As Anca Mihalache of Aero Care says: "I consider the LEAP engine to be a smart investment for long-term portfolios. Its efficiency and sustainability make it a strong performer, not just in the air but also on the balance sheet. As data matures and the spare parts market deepens, lessors are well positioned to maximise value while maintaining confidence in the engine's strong aftermarket potential." ■

Aero Norway – a phased approach to LEAP integration

Away from the monolithic global MRO providers like Lufthansa Technik, smaller companies are also making moves to ensure they are able to meet the coming demand for LEAP services.

Kenneth Johnston, LEAP Programme Manager at Aero Norway (pictured above), says the initial signs are that MRO services may be struggling to cope with demand.

"We've been receiving numerous enquiries about support, which suggests that current capacity is a significant issue," he says.

The Stavanger-based provider has an enviable reputation for the overhaul of the CFM56 and has appointed Johnston to oversee its cautious foray into the brave new LEAP world.

Johnston says: "There is substantial opportunity for third party MRO providers due to the open structure of the LEAP engine's MRO ecosystem structure. With rising demand, expanding maintenance capacity has become increasingly essential.

"Unlike the CFM56, which enjoyed a long on-wing life, the LEAP engine is facing issues that are resulting in earlier removals. A significant challenge is the durability of the Stage 1 High Pressure Turbine (HPT) blade, particularly in the MENA region, where the harsh operating environment is causing engines to be pulled off-wing much sooner than expected."

Aero Norway's chosen strategy in response is a phased approach focusing initially on specific capabilities rather than immediately expanding the facility for complete engine overhaul.

The organisation has recently obtained the required qualifications and EASA/FAA approvals to implement the Reverse Bleed System (RBS) modification, as outlined in the Service Bulletin. This modification helps prevent fuel nozzle coking by controlling the thermal environment of the fuel nozzle after engine shutdown.

Johnston says: "The company plans to concentrate on module level repairs, specifically investing in tooling High Pressure Turbine rotor and stator modules. The goal is to receive these modules from other facilities that lack in-house capability to service them.

"For instance, quick-turn or on-wing services facilities can manage engine disassembly and reassembly but lack the capability to work on engines modules themselves. We view this modular approach as a stepping stone toward supporting larger engine work scopes."

TOOLING UP

Moving on from module repairs, the costs and commitment involved in evolving from a renowned CFM56 shop to an equivalent LEAP facility are far from trivial. For a start, there are the specialised tooling requirements. "The tooling required for the LEAP engine is entirely different from that used for the CFM56, which remains our core business," says Johnston.

Compounding the challenge is the fact that tooling for the a specific module on the LEAP-1B differs from that of the LEAP-1A, necessitating additional investments.

Johnston says: "Introducing new tooling and processes is particularly challenging, especially as it must be managed alongside our core CFM56 business."

Aero Norway is also evaluating the suitability of its test cell, as the LEAP engine demands higher airflow than the CFM56.

Visit our YouTube channel for an in-depth interview with Aero Norway's Chief Operating Officer and veteran propulsion engineer, Dag Johnsen.