May 2022

AIRFINANCE JOURNAL

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A recovery market

Shop visits will increase this year giving a welcome boost to the engine maintenance market.

The engine maintenance market will see more activity in 2022 as airline operators, encouraged by a return to travelling and gradual lifts of government restrictions, will take the view of further longer-term investment.

Over the past two years, their priority has been managing cash to survive. One of the consequences has been engine shop visits rescheduling as airlines have had to maximise the greentime on their engines.

Engine shop visits are driven by flying activity and the market is anticipating an increase in engine flying hours. There is always a little bit of a lag in terms of how that comes through, but shop visits are predicted to increase this year, probably a little bit less than flying hour activity.

Last year, airlines opted to leave until last minute the decision to address capacity because they were not sure about their summer schedule. This time, airlines are more proactive in preparing for the summer season.

"We see more developments with airlines this year especially with aircraft being reactivated. Every airline is trying to add capacity," comments a source.

But he warns that the balance between too much capacity and not capturing market share is tight.

"Some engine shops are busy but I firmly believe airlines are still swapping engines on their active fleet and burning greentime," says one engine leasing source.

However, as the market recovers and airlines generate more revenues, they will take the view of further longer-term investment.

"We will probably see a more significant ramp-up in 2023 and 2024 on the current production engines and maybe that might be the last wave. The rest of the engine market may be more staggered and with a more consistent level of engine shop visits rather than a peak," says the source.

Airlines still aim to optimise the engines within a fleet with swaps as much as possible rather than putting an engine into full performance restoration.

It is the right way to go as the market recovers.

Some engines have longer lives than others, so there is always a possibility of a longer life than airlines want to exploit.

The part-out business is no longer flooded with materials.

It is recovering and there is definitely good life-limited parts, modules and high-pressure turbine blades moving quickly. There is some competition for run-out engines, though.

A good indicator about the recovery of the aftermarket is the value of run-out narrowbody engines. "I believe we will hit $2 million the end of this year," says the lessor source.

"There are also more players in the aftermarket compared with a few years ago. Some companies were established during the Covid period but there are still a lot of entities that are purely airframe focused, and hardly touch engines. So the engine aftermarket space is never going to be as crowded as the airframe market. There are about three to four times more airframe players than engine aftermarket players."

Widebody market

The widebody market traditionally lags behind narrowbodies, and just like aircraft investors, engine investors are typically less attracted to this end of the market.

With a smaller installed base and a less-liquid market, the twin-aisle sector is seen as a riskier space to operate. There has always been a view that by taking more steps to address investor concerns about the aftermarket, original equipment manufacturers could do more to make twin-aisle engines a more attractive investment.

The widebody market is still struggling to recover, and activity is slow when compared with the narrowbody market. As airlines prepare for the summer period with more long-haul flights, activity in the widebody market is mainly on newer engines.

"It is still quiet on most markets but there is activity on the Trent 700 engine as more Airbus A330s head back in operations," says the engine source.

Another source tells *Airfinance Journal* that inter-lessor trading activity has been relatively buoyant, with some parties only interested in established players.

"Some mid-market companies have managed to grow their fleet substantially and are now considering orderbooks," he says.

Lessor sources also note increased scrutiny over a business strategies.

"For some, the focus is on growing the portfolio on the technology engines and not to concentrate on current/mature engines," says the source. "That trend started in the second half of last year and the winter period."

The outlook for values is positive and engines are increasingly being placed on long-term leases.

New engine residual values will continue to benefit from the absence of a narrowbody replacement.

OLIVIER BONNASSIES
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Airfinance Journal

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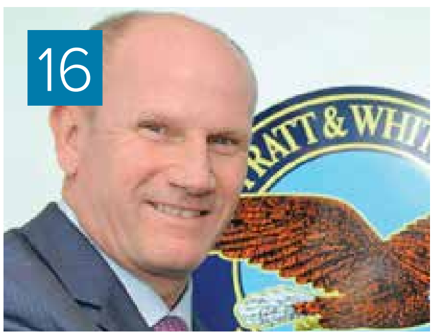

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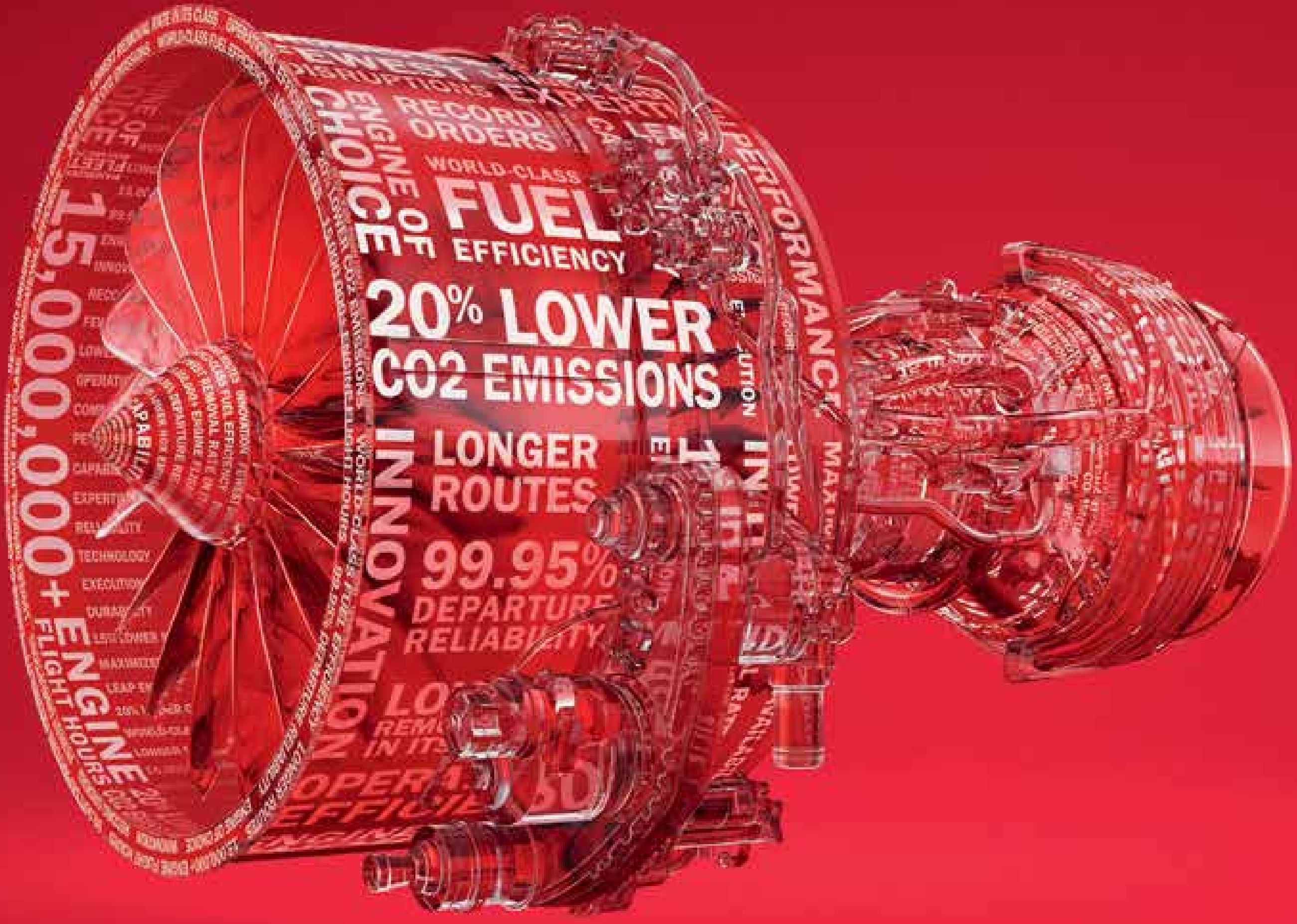
Printed in the UK by Buxton Press, Buxton, Derbyshire.

Registered in the United Kingdom 1432333 (ISSN 0143-2257).

Airfinance Journal (USPS No: 022-554) is a full service business website and e-news facility with printed supplements by Euromoney Institutional Investor PLC.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GE cuts $50bn debt with GECAS sale

The manufacturer expects revenue to grow this year after a difficult 2021.

General Electric (GE) swung to a net loss of $3.9 billion in the fourth quarter, compared with net income of $2.4 billion a year earlier. Revenue for the company fell 3% to $20.3 billion compared with 2020.

GE delivered $3.8 billion in industrial free cash flow in the three months.

The company says in an earnings release that the GECAS sale "helped GE reduce gross debt by more than $50 billion in 2021 and more than $87 billion over the past three years".

During the final quarter of 2021, on 1 November, GE completed the sale of its GECAS leasing business to Aercap for $30 billion.

On 9 November, GE also announced that it would be splitting into three separate companies during the next 24 months, focused on healthcare, aviation, and energy, but with the aviation segment becoming its main focus by early 2024.

"We're supporting the recovery of the aviation industry today and creating a future of smarter, more sustainable and efficient flight," said chief executive officer, Larry Culp, in January.

He expects GE to return to revenue growth in 2022, with aviation revenue increasing more than 20% in 2022, based on the continued commercial market recovery.

Culp says that a double-digit increase in orders in 2021 supports this growth outlook.

He adds: "We're seeing real momentum and opportunities for sustainable, profitable growth from near-term improvements in GE's businesses, especially as aviation recovers and our end markets strengthen. Our dramatic debt reduction means we can further intensify efforts to strengthen our operations and play offence, setting us up to deliver between $5.5 to $6.5 billion free cash flow in 2022 and more than $7 billion in 2023.

"As we lay the groundwork to create three independent companies focused on critical global needs, we're encouraged by the support from our customers, employees and investors. We're confident that our businesses will deliver long-term growth and value."

GE Aviation's revenue fell 3% to $21.3 billion last year from 2020 because of fewer commercial engine deliveries. The segment's profit margin of 13.5% expanded nearly 800 basis points, driven by a 10% increase in commercial services shop visits and operational cost reductions.

GE Aviation sold 1,487 commercial engines in 2021, with total engine orders for 2,248. Its LEAP engine recorded sales of 845 units, with 1,457 orders.

Last year, aviation delivered a $4.6 billion free cash flow, up $2.6 billion from 2020. This was driven by services strength aligning with the market recovery, improved working capital, including strong customer collections and timing of customer allowance payments, says the company.

We're seeing real momentum and opportunities for sustainable, profitable growth.

Larry Culp, chief executive officer, GE

Aftermarket services

Culp says the company is positioned to lead as the commercial aftermarket recovers and military grows, supporting the industry today and sustainability for the long term.

Aftermarket services make up about 80% of the company's more than $400 million backlog and more than half of its revenue.

Culp says GE is encouraged by its performance, which reflects its actions and a continued market recovery.

"While the current GE CFM departures are down 25% versus '19 levels, given recent volatility due to the Omicron variant, it wasn't a material impact in 2021. Shop visits once again were higher than we initially anticipated, and green time utilisation continues to lessen. Along with our customers, GE remains confident in the recovery while actively monitoring the impact of travel restrictions," he adds.

The company expects GE CFM departures to continue to improve this year to represent 10% off the 2019 levels. It anticipates total shop visits to be up about 20% year on year.

"We expect revenue will increase more than 20% driven by strong worldwide shop visit growth and the ramp of LEAP engine deliveries. Margins will expand despite commercial mix pressure as LEAP engine deliveries increase while we increase our investment in new technology. Looking across our other segments," says Culp.

He adds that, in 2021, the inductions and the shop visits increased sequentially at any step along the way.

"Our customers have worn through a good bit of the green time capacity that they had as they prepare for what I think many of us expect to be improved conditions before too long here in '22 and then going into '23," says Culp. "Everybody wants to be ready. And I think that's more or less what you see, not only in our results in 2021 but is inherent in what we've shared relative to our outlook for 2022."

Aercap completed the acquisition of GECAS from General Electric (GE) on 1 November

Departing CEO confident of **Rolls-Royce future**

Rolls-Royce's chief executive officer, Warren East, says the business opportunities and a more balanced portfolio will make the company better going forward.

"There is a lot of opportunity out there and it's making the investment calls and balancing that investment alongside looking after our existing business," said Warren East, Rolls-Royce's chief executive officer, during the company's 2021 full-year earning calls.

"We talk about value creation from our installed fleet, for instance, in civil aerospace by extending their time on wing. That takes engineering effort, resource investment, and so on, but so do the opportunities in net zero that we talked about both within power systems, actually within things like electrical aviation and even in defence addressing net zero opportunities. So the challenges are those," he adds.

East, who plans to step down at the end of this year, acknowledges that "there have been challenges", but Rolls-Royce has built on the cultural and organisational improvements it has made to work through them, delivering on its commitments and create a better business.

"We have simplified the group, fundamentally improved our underlying operations and driven long-term change. Rolls-Royce is a dramatically different business today: a leading industrial technology company that is not only addressing the energy transition but embracing the opportunity it presents to generate substantial business growth, including through the creation and nurturing of new businesses with very significant potential," he says.

East adds the skills of the Rolls-Royce people, the strength of its technologies and the depth of its relationships give the manufacturer tremendous opportunities to pioneer the vital solutions needed to create a net zero carbon future. "This is the biggest technological shift for the group since the arrival of the jet engine," he says.

The UK company reported an underlying £10 million ($13 million) net profit last year, reversing a £4.03 billion net loss in 2020.

In 2021, Rolls-Royce posted a £414 million operating profit, up from £2 billion operating loss the previous year. Operating margin was 3.8%.

There is a lot of opportunity out there and it's making the investment calls and balancing that investment alongside looking after our existing business.

Warren East, chief executive officer, Rolls-Royce

Revenues totalled £10.95 billion last year versus £11.43 billion in 2020. Civil aerospace now contributes to about 40% of its total revenues. The company notes that lower widebody volumes and lower shop visits in civil aerospace were balanced by growth in both defence and power systems.

Gradual market recovery in aviation and the non-repeat of those Covid-related one-off charges from 2020 helped to enhance Rolls-Royce's financial performance. Overall, revenues were down 10% on the previous year. Original equipment (OE) revenues were down 29%, reflecting the reduction in engine deliveries as fewer large engines were required to fulfill customer build schedules. This was offset by an increased revenue from the sales of spare engines.

Services revenue was up 6% on the previous year and included £214 million of positive long-term service agreement catch-ups compared with negative catch-ups of £1 billion in 2020.

They also reflected lower shop visit volumes and a reduced contribution from the V2500 engine programme. The underlying operating loss of £172 million was significantly better than the £2.5 billion loss in 2020.

"We continued to focus very heavily on those areas that are in our control and we're seeing sustainable cost benefits from that restructuring programme," says Rolls-Royce.

Free cash outflow from continuing operations was negative at £1.5 billion and trading cash outflow from continuing operations was negative at £1.2 billion. Both were substantially improved on the previous year period helped by robust progress on cost reduction, stronger operating performance, including higher flying hour receipts in civil aerospace, and reduced capital expenditure.

The working capital outflow totalled £800 million in 2021 and was mostly driven by concession payments and lower OE deliveries in civil aerospace.

While the cash flows were negative, the company is ahead of expectations, says East.

The restructuring programme delivered more than £1.3 billion run rate savings and the company is on track to generate about £2 billion total proceeds through disposals.

"We are committed to rebuilding our balance sheet and returning to an investment-grade credit profile in the medium term. We're on the pathway to achieve this as we benefit from reducing uncertainty, improving financial performance and a strong strategic focus on the energy transition," said chief financial officer, Panis Kakoullis.

Rolls-Royce ended the year with £2.2 billion of net debt, including £1.8 billion of leases.

The company had £7.1 billion of liquidity, including £2.6 billion in cash, at the end of last year after repaying the 2021 €750 million ($818.2 million) bond and the £300 million Covid Corporate Financing Facility.

"A strong balance sheet is very important for us. We will balance the pace of that rebuild with the investment opportunities across our portfolio to make sure that we maximise the long-term return for our shareholders," adds Kakoullis.

The original equipment manufacturer says the launch of the Airbus A350 freighter in 2021 represents a significant opportunity for the company's Trent XWB engine. It secured 58 engine orders for the A350F last year.

Restructuring programme

Rolls-Royce says the fundamental restructuring programme in civil aerospace was largely completed resulting in higher productivity and sustainably lower costs, better suited to the current environment and positioned well for future growth.

"It was about rightsizing in the short term and then taking advantage of efficiency and productivity enhancements, so that we can scale up output without a corresponding increase in operating costs," says East. "Not only have we exceeded our run rate savings target and we've removed more than 9,000 roles across the group and we have done so one year ahead of schedule."

East says the civil aerospace business operation is now about one-third smaller than it was in terms of footprint and headcount. "That makes civil leaner, a much more efficient and productive business and one that is ready for future growth. The focus now is on ensuring the benefits we've achieved are sustained."

He adds: "We have installed machines which reduced cycle time hugely. We've changed our design processes, again reducing cycle time hugely, driving up the productivity. In fact, with the reduced level of activity that we're still seeing in 2021, we have underutilised assets, but those assets will be utilised when the growth comes back and so the growth will be able to come back as we said with a relatively small increment in terms of operating costs."

East anticipates a steep increase in activity, which "we saw second half on second half in the '21 numbers to continue, albeit at a slightly sort of slow rate, because you're building on a larger base as we go through '22".

The consensus forecast would be for about a 50% increase in flying hours, he says, but in terms of shop visits and planned number of shop visits, Rolls-Royce is anticipating about a 30% increase in load on its factories.

"That's really driven," he says, "by the component demand from those shop visits." Λ

Safran profits 10% down in 2021

The company enjoyed "operational and financial progress" despite a drop in profits.

Safran reported a €760 million ($864.2 million) net profit in 2021, down 10% from the from €844 million recorded the previous year.

Its propulsion department accounted for almost half the company's revenues at €7.44 billion.

Services totalled €4.64 billion in revenues last year, versus €4.69 billion in 2020. Original equipment (OE) deliveries were €200 million down in revenues over the 12-month period at €2.8 billion.

The company says the global narrowbody capacity in 2021 was uneven across geographies but increased throughout the year.

In 2021, narrowbody available seat miles (ASK) were at 63% (on average) of 2019, with the fourth quarter of 2021 at 75% of 2019's corresponding quarter.

Safran says propulsion's slight decrease in sales was mainly because of civil OE volumes (high thrust and CFM56 engines). In 2021, combined shipments of CFM engines reached 952 units (845 LEAP and 107 CFM56), compared with 972 (815 LEAP and 157 CFM56) in the previous year. Military engine deliveries were up driven by Rafale. Civil aftermarket increased by 7.1% because of a higher contribution from services contracts and, to a lesser extent, from spare parts sales for the CFM56.

Sales in the fourth quarter increased by 13.7% because of civil aftermarket revenue, up 54% compared with the fourth quarter of 2020 and up 32% from the third quarter of 2021.

Safran's propulsion revenues in the second half of 2021 exceeded those of the first half of 2020. Between July and December, revenues totalled €4.19 billion, compared with €3.6 billion the previous period.

CFM engines shipments reached 952 units last year

The company says that civil aftermarket was down 53% in the first quarter of last year, up 55% in the second quarter and up 44% in the third quarter.

Safran's recurring operating income reached €1.8 billion in 2021, a 7.1% improvement over the previous year. This was driven by continued operational improvements and contained research and development expenses. It included scope changes of €7 million and a currency impact of €16 million.

The company's recurring operating margin improved by 160 basis points at 11.8% of sales (10.2% in 2020).

Propulsion's operating income stood at €1.34 billion in 2021, up from €1.19 billion in 2020. Operating margin increased by 2.4 points to 18% driven by civil aftermarket and military OE positive contributions. Profitability was impacted by lower CFM56 deliveries. Helicopter turbine activities had a stable contribution compared with 2020.

Operating profit was €1.4 billion last year, giving a 9.2% operating margin. This was up from €1.2 billion in 2020.

Safran took a €405 million one-off charge last year, including €79 million in restructuring costs and €309 million of impairment for several programmes.

Free cash flow generated totalled €1.68 billion. This was driven by cash from operations of €2.18 billion, a positive change in working capital and a lower capital expenditure.

Net debt was €1.54 billion at 31 December 2021, down from €2.79 billion at the end of 2020.

At the end of December 2021, cash and cash equivalent stood at €5.25 billion, up from €3.75 billion at the end of December 2020. In 2021, Safran continued to diversify, optimise and lengthen its debt maturity profile with several new transactions.

Commenting on the company's results, Safran's chief executive officer, Olivier Andriès, said: "Twenty twenty-one was an important year for Safran, marked by significant operational and financial progress. We delivered solid margin and cash performance, exceeding our outlook. In 2022, we see real momentum for sustainable growth, and are ready to raise overall equipment production rates and accelerate the pace of investment for decarbonisation."

The company forecasts €2 billion of free cash flows this year based on revenues of €18 billion to €18.2 billion and an operating margin of 13%.

Safran anticipates narrowbody ASK to increase in the range of plus 35% to 40% versus 2021 with likely short-term volatility. The company expects the number of LEAP deliveries to increase in line with the target of about 2,000 engines in 2023. Λ

MTU Maintenance starts SAF tests on **V2500 engines**

MRO provider is moving on with plans to reduce carbon dioxide emissions while achieving its earnings and cash-flow targets despite the disruption caused by the coronavirus pandemic.

MTU Maintenance has partnered with US carrier Jetblue Airways for the testing and data-gathering on sustainable aviation fuels (SAF) with the airline's V2500 engines following on from shop visits in Hannover, Germany.

Conducted in a controlled ground environment, test runs will initially be performed with a 10% SAF fuel blend and can be expanded to up to 50%, the current regulatory limit, if required.

This SAF is sustainably derived from waste fats, oils and greases and has up to an 80% lifecycle greenhouse gas emission reduction per gallon compared with the conventional jet fuel it replaces.

"MTU Maintenance is the first MRO [maintenance, repair and overhaul] provider worldwide to be offering test runs with SAF," says Michael Schreyogg, chief programme officer, MTU Aero Engines.

"We are excited to be doing our part in reducing carbon dioxide emissions at our sites and providing more sustainable MRO solutions for customers across the lifecycle. MTU is committed to the Paris Climate Agreement and therefore aiming to become carbon neutral in operations across our German production facilities."

The company began testing with the V2500 engines in November 2021 and looks to expand this to other engine types, such as the popular CFM56-7B and GE90 engines.

MTU says SAF is a key initiative in reducing the climate impact of the aviation industry, and increased and reliable supply will be instrumental to this. "At MTU, we are implementing SAF early and promoting its usage to and for our customers."

Sara Bogdan, Jetblue Airways director of sustainability and environmental social governance, says: "Our goal is to achieve net zero carbon emissions by 2040, and implementing sustainable initiatives along the supply chain, and gathering the necessary data to ensure these initiatives are safe, practical and meaningful, is a key part of this work."

MTU results

MTU Aero Engines published its preliminary figures for 2021 in the first quarter of this year with revenue rising 5% to €4.19 billion ($4.77 billion). The company's operating

The PW1100G-JM for the A320neo was the main revenue driver in the commercial engine business

profit was 13% higher at €468 million over 2020 when it was €416 million. The adjusted earnings before interest and tax (Ebit) margin was 11.2%, compared with 10.5% in 2020.

Net income climbed to €342 million in 2021 versus €294 million the previous year.

"In 2021, MTU once again demonstrated its resilience in the face of crisis. Despite continued disruption and uncertainty as a result of the coronavirus pandemic, it was a successful year in which we fully achieved our earnings and cash flow forecasts," says Reiner Winkler, chief executive officer, MTU Aero Engines.

As the market remained volatile because of Covid-19, MTU gave more precise guidance when it presented its half-year figures at the end of July and after the first nine months. The most recent forecast was for revenue of between €4.3 billion and €4.4 billion.

"In both the OEM [original equipment manufacturer] and the MRO business, revenue was slightly below our expectations in 2021, so total revenue was slightly lower than had been forecast," says Winkler.

The target for the adjusted Ebit margin was 10.5%. The operating profit and adjusted net income had been expected to develop in line with one another.

Outlook for 2022

Commercial maintenance should show the strongest upward momentum in 2022, with organic revenue growth in the mid- to high-20s percentage range. The increase in revenue in the commercial series business should be in the mid- to high-teens percentage range.

In the commercial spare parts business, MTU predicts the rise in revenue will be in the mid-10s percentage range. In the military business, revenue growth in the high single-digit percentage range is expected.

Overall, MTU projects a revenue range of between €5.2 billion and €5.4 billion in 2022. The company expects growth in adjusted Ebit to be in the mid-20s percentage range in 2022. Adjusted net income should increase in line with the operating profit, predicts the company.

Higher revenues

In commercial maintenance, MTU raised revenue by 9% to €2.74 billion in 2021.

About 60% of the revenue mix was work in MTU's core MRO business and around 40% comprises maintenance work on the geared turbofan.

"On a dollar basis, MRO reported a 13% rise in revenue, which was not quite as strong as had been anticipated," says chief financial officer, Peter Kameritsch.

MTU had assumed the commercial maintenance business would report organic revenue growth in the mid-10s percentage range. The main revenue drivers in this business were the PW1100G-JM engine for the Airbus A320neo aircraft and the V2500, which is used on the current generation A320s.

Revenue was stable in both the commercial engine business and the military engine business in 2021.

In the commercial engine business, MTU generated revenue of €1.67 billion versus €1.05 billion the previous year. Organic revenue increased by 5% in the spare parts business but fell by 6% in the series business.

"A quarterly view shows an organic improvement in both areas," says Kameritsch. "In the fourth quarter, revenue from the series business was about 20% higher than in the fourth quarter of 2020 and in the spare parts business the increase was around 40%."

The PW1100G-JM for the A320neo was the main revenue driver in the commercial engine business.

ATR performs 100% SAF in one engine

The regional aircraft manufacturer is moving closer to sustainable aviation fuel certification for its ATR aircraft.

ATR successfully performed a series of ground and flight tests on its ATR72-600 prototype aircraft, cumulating seven flight hours with 100% sustainable aviation fuels (SAF) in one engine in early February.

The aircraft was powered by Neste MY Sustainable Aviation Fuel produced from 100% renewable waste and residues raw materials, such as used cooking oil.

These tests are part of the 100% SAF certification process of ATR aircraft.

In September 2021, ATR announced a collaboration with Braathens Regional Airlines and SAF producer Neste to accelerate this certification.

The three companies had been working closely together, targeting a demonstration flight this year flying with 100% blend SAF in one engine and 50% SAF in the other, for an anticipated emissions reduction of 64%.

It is expected that an ATR flying with 100% sustainable aviation fuel in both engines would reduce CO_2 emissions by 82%, if it were flying one of Braathens Regional Airlines' typical routes.

This collaboration follows the successful Perfect Flight venture in 2019 in which every aspect of a BRA ATR flight was optimised, including the use of a 50% SAF blend. This led to a saving of 46% of CO_2 emissions, compared with a standard flight.

The aim is to complete the certification process of ATR aircraft for 100% SAF by 2025.

SAFs are a key pillar of the aviation industry's decarbonisation strategy, with an immediate impact in reducing CO_2 emissions. It is expected that an ATR flying on a typical regional route with 100% SAF in both engines would reduce CO_2 emissions by 82%.

Stefano Bortoli, ATR's chief executive officer, says: "As the regional market leader, our aim is to lead the change to decarbonisation. Already emitting 40% less CO_2 than similarly sized regional jets, ATR turboprops are the ideal platform to offer significant advances in the reduction of CO_2 emissions. The achievement of this great milestone shows that we are fully committed to making the use of 100% SAF possible and helping our customers meeting their objectives to provide even more sustainable air links – not in 2035 or 2050 but in the coming years."

ATR, as the most sustainable on the market, burning up to 40% less fuel and emitting up to 40% less CO_2 than a similarly sized regional jet, is the ideal aircraft on which to deploy 100% SAF. Today, with no SAF on board, if ATR aircraft replaced every regional jet departing from Sweden, nearly 32,000 tonnes of CO_2 could be saved, for a reduction of 42% in CO_2 emissions. These eco-credentials were validated when the aircraft became the first to become eligible for green financing in 2019, when Braathens Regional Airlines modernised its fleet with ATR aircraft replacing ageing, regional jets.

Jonathan Wood, vice-president Europe, renewable aviation at Neste, says the company produces 100,000 tonnes of SAF a year, but by 2023 it will have a significant portion of Swedish demand.

Braathens expects to operate flights with 50% SAF by 2026 and 100% SAF by 2031.

New-tech engines stay out in front

A strong recovery in narrowbody aircraft utilisation has led to greater value stability for engines equipping mature aircraft. The new-technology engines continue to lead.

The market has peaked up over the past few months with the reopening of travel. One source says there is a general consensus that there is not going to be enough narrowbody aircraft available to operate for the summer season.

The V2500-A1 market is marginal and essentially a part-out market and greentime. This engine is stable and at the value floor, says one pollster.

Backlog on the V2500-A5 engine shop work has been affected by the February 2021 airworthiness directives (AD) that address potential anomalies in the material during inspection of the high-pressure turbine (HPT) stage 1 and stage 2 stage hubs.

"The AD is about the HPT stage 1 and stage 2 fault disk that requires an inspection with defined limits. There have been numerous AD revisions and inspections for cracking and potential replacement," says an engine source.

He adds that the V2500 maintenance market is relatively narrow and limited and there are not a lot of shops performing engine works. "The engine needs to be done in the shop and this has led to a lot of backlog."

The V2500-A5 has an established fleet but issues persist, says another engine lessor. "It continues to lease well and will do like the -5B and -7B in future."

Another pollster says the V2500-A5 engine is a strong liquid market. "Demand is driven by AD on HPT hubs."

A lessor says: "We have a situation now where the V2500 engine is getting into the mature phase, and its intervals are rather shorter than the CFM56 engine equivalent. There is a lot of demand for shop visits."

The V2500-A5 engine is dominant on the Airbus A321 models and this is where the market is strongest.

The CFM56-5B market compared with other narrowbody engines is relatively "soft" at the moment and has not recovered, says the lessor. "There is oversupply. The -5B is dominant on the Airbus A319 model, which is where the market is softest."

On the freighter narrowbodies, the CFM56 engine appears to be the most popular choice.

The engine lessor explains that a modification which can be done on the thrust reversers allows a reduction of noise, especially for night-time operations.

"There is still upside in the -5B engine market. Available engines will present multiple options due to factors affecting the host aircraft fleet. Values now make the engine," says a pollster.

"The -5B is still in good demand. We see demand for package deals where customers are after multiple engines as they try to address capacity or wider fleets. It is probably quicker for an airline to address capacity ramp-ups with an A320 or [Boeing] 737NG rather than relying on the aircraft OEMs [original equipment manufacturers] and be potentially delayed in their fleet plans," says another pollster.

Still, the CFM56-5B market continues to lag behind the CFM56-7B or V2500-A5, which have both benefitted from domestic market recovery, especially in the USA and China.

The CFM56-7B demand seems balanced and values are recovering on the leasing side, particularly on greentime leasing.

On the aftermarket, the -5B and -7B run-out engines are trading between $1.2 million to $1.5 million depending on the quick engine change and assuming minimum of life-limited parts life, says the lessor.

"Those were trading between $1.8-2 million per engine pre-Covid. It has not fully recovered yet, but it could recover in the fourth quarter of this year. We will see how airlines perform in the summer and have better long-term market conditions," adds the lessor.

There is a distinction in the -7B engine market. Depending on the operations, some airlines may lease the 24,000lbs thrust but the 22,000lbs is where the issue is for demand.

The rentals in the narrowbody engine market are creeping up.

The short-term lease rates will recover quicker than the long-term lease rates, which are still being priced below pre-Covid-19 levels.

"Some lessors are placing -7B engines on three-year leases at $75-80,000 a month. That would go up but the lease rates are not there yet," says the lessor.

Another lessor points out that the issue is there are too many greentime engines.

"Some that purchased greentime engines prior to the Covid pandemic paid a premium. Consequently, they need to get revenues against their asset and unfortunately are placing their engines at relatively low lease rates to ensure cash flows," he states.

The market for 757 aircraft is now essentially a freighter market with low utilisation.

Delta Air Lines, FedEx and UPS are the primary operators of Pratt & Whitney-powered 757s. Aersale bought 24 units from American Airlines last autumn.

There seems to be a market for trading. "The engines have their price, and we have seen market values exceeding base values," says one pollster.

The new-technology engine market is more balanced.

Narrowbody engines

	Investor appeal	Remarketing potential	Residual value
CFM56-3C (737 Classic)	2.50	2.83	3.08
CFM56-5A (A320 Family)	1.50	1.83	2.25
CFM56-5B (A320 Family)	4.75	4.42	5.00
CFM56-7B (737NG)	5.50	5.25	5.33
CFM LEAP-1A (A320neo Family)	6.36	6.09	5.82
CFM LEAP-1B (737 Max Family)	6.36	5.91	5.73
IAE V2500-A1 (A320 Family)	1.25	1.58	1.58
IAE V2500-A5 (A320 Family)	4.67	4.67	4.83
PW1100G (A320neo Family)	6.27	5.91	5.45
PW1500G (A220 Family)	5.45	4.91	5.00
PW2000 (757s)	3.08	3.42	3.42
RB211-535 (757s)	3.08	3.50	3.33

NB: Rating of 1 means lowest rating, 7 highest. *Source: Airfinance Journal* engine poll, March 2022

The LEAP-1B has been reintroduced into the system and the market is waiting to see if there are similar problems as the -1A before, according to one lessor. "As a consequence, everybody is waiting on will there be additional demand requested."

Boeing delivered 245 Max aircraft in 2021. With production on track to reach 31 aircraft a month sometime this year, the US manufacturer must ramp up 737 Max deliveries significantly to keep its inventory winding down and newly built aircraft flowing to customers.

The LEAP products are described as the heart of the market for investors. But one lessor cautions that book values are restricting deals from its perspective.

He adds that the PW1100G engine market is similar to LEAP engines. "Still on-going developments from a technical standpoint that will determine how long this engine stays on-wing. We have bid on this engine – book value constraints were a factor we felt."

Another lessor says demand has increased for spare engines since the beginning of the year.

"We have seen a lot of demand but not in the traditional way. Airlines are managing their engines pool and using greentime on their classic fleets as they reintroduce some of their aircraft into the system."

The lessor representative says the trend is different for new-technology aircraft. "New-technology aircraft fleets are also being reintroduced but are under warranty periods from the manufacturer, therefore demand is not as significant."

He observes that in the current high oil price environment, most airlines are looking to operate their new-technology aircraft fleets. He expects aircraft manufacturers to speed up deliveries of parked Max aircraft while those that have not returned to service yet, may also enter service again.

Still the gap between what Boeing can deliver and capacity that airlines want to deploy will be filled by existing types.

He observes that aircraft OEMs are facing the dilemma of how quickly they can ramp-up production rates to reasonable levels to allow the airlines transition to new-technology aircraft.

"The market is starting to shift to new-technology engines and more engine lessors are moving into that space. Some have the financial resources to support their customers. Others are focusing on acquiring used serviceable materials, greentime engines off the aircraft to lease the engines."

He expects more airlines to come up with sale and leaseback opportunities on new-technology engines.

"Engine lessors are focusing on managing their portfolio the best possible way to address the demand in the market in existing technology engines but also grow their exposure to new-technology engines," he concludes. "It is inevitable that as the demand grows for new-technology types, the largest engine lessors migrate to this market."

Widebody market
Widebody aircraft utilisation has steadily improved but at a slow pace because long-haul flying is not expected to recover fully for another two years.

The slowed recovery has continued to depress engine values of mature fleets.

"The widebody market is still struggling to recover fully and, as expected, we don't see as much activity when compared with the narrowbody market. We see demand for sale and leaseback spare engines on the Trent XWB side, but on the widebody, short-term spares engine requirements are usually not plentiful. This is because airlines are normally covered by the OEM's long-term lease power by the hour (PBH) contracts," says a source.

The perception of the widebody market is activity mainly on new engines.

"It is still quiet on most markets but there is activity on the Trent 700 engine as more Airbus A330s head back in operations. There seems to be a trend of short-term lease appetite for this market with A330 operations during the next six months, not long term," says a source.

He adds that there has been increasing talk about aftermarket services on the Trent 700, with Rolls-Royce offering spare parts support on a mature basis. "This has been considered but it could be a reality now and be helpful."

The GE90 market represents the long widebody hangover, and is a depressed market, observes a source. Market values of GE90 engines have reduced significantly over the past two years, but were arguably decreasing prior to Covid-19.

Some 777 operators have expressed interest for the GE90 engines to get additional capacity. Those are typically charter operators which are after large capacity aircraft.

Another pollster confirms interest in the GE90 market.

"There seems to be some pick up in this GE90 market. Some engines are being sold for part-out and the numbers are quite high. This may reflect that some are looking at being there in the long-term support basis," he comments.

The freighter market will certainly help the GE90 engine market. There has been an increasing appetite over the past year with Mammoth Freighter launching a conversion programme with Delta Air Lines Boeing 777-200LR aircraft, while the first converted 777-300ERSF by GECAS is scheduled by the end of this year.

The Trent 1000 has been impacted by the pause in deliveries of the 787 variants, and some believe the significant entry into service (EIS) issues are resulting in losing large market share to the GEnx-1B model. More than 110 787s are undelivered and in storage because of production quality issues.

One pollster says the aircraft longevity, because of technology and limited other future options, should keep this market stable despite being the unfavoured engine option.

The Trent XWB values are holding firm and the engine is Rolls-Royce's strongest product. As one source says, it is a "reliable engine on a growing fleet with residual value likely dictated by the OEM".

"It will be interesting to see what happens with the Qatar Airways A350 issue with Airbus and if that means more impairment and grounding of aircraft? What would that do to the engines?" asks another source.

The GEnx-1B remains a strong engine/aircraft platform. The GEnx-2B, which is predominantly cargo, has a limited appeal.

The CF6-80 market is still buoyant. Freight drives demand, and some North American operators are resilient in 767 operations. Boeing still get orders for the factory-built 767F version.

Despite the market moving to the 777 conversions, the 767-300ER has benefitted from a second life in the cargo conversion market over the past few years, although Boeing continues to sell the factory-built 767F model.

Widebody engines

	Investor appeal	Remarketing potential	Residual value
CF6-80 (747s, 767s)	3.67	4.50	4.17
GE90 (777s)	2.75	2.92	2.92
GEnX (787s, 747-8s)	5.82	5.18	5.27
GP7200 (A380)	1.33	1.25	1.25
JT9D (747s, 767s)	1.00	1.00	1.33
PW4000 (A330s, 747s, 767s, 777s)	3.09	3.36	3.18
RB211-524 (767s, 747s)	1.33	1.83	1.75
Trent 700 (A330s)	2.58	2.92	2.50
Trent 800 (777s)	1.58	1.50	1.42
Trent 900 (A380)	1.42	1.25	1.33
Trent 1000 (787s)	4.00	3.73	3.27
Trent 7000 (A330neo)	4.00	3.36	3.36
Trent XWB (A350s)	5.09	4.45	4.27

NB: Rating of 1 means lowest rating, 7 highest. *Source: Airfinance Journal* engine poll, March 2022

"It is still quiet on most markets but there is activity on the Trent 700 engine as more Airbus A330s head back in operations."

The Chicago-based company found strength in the widebody market supported by strong demand for freighters last year and recorded 84 orders for 777F, 767F and 747-8F models, which beat the previous record of 83 freighters ordered in 2018.

The CF6-80 market benefits from the Amazon effect, high demand because of a shortage of good engines and USM parts, says a pollster.

The CF6-80C2B6F is the only opportunity on 767s but the market remains volatile.

"Engine values have been on or above expectations for some time," remarks another pollster.

Regionals

The regional engine market improved over the past year with the exception of the old-generation engines for turboprops.

Demand for CF34 engines with greentime is expected to be quite strong for mid-life aircraft as PR and life-limited parts costs are high, observes one pollster.

The CF34-8C market continues to be active. One pollster says it is a concentrated market and the fleet will benefit from the move away from the 50-seat CRJ200/ERJ145s in the medium term. "It is a long established engine lessor market," he adds.

The biggest drive in the CRJ700 market can be the engine condition and its costs relative to the trading of aircraft, which has been around the $3 million to $5 million range.

The -8E market is well established and currently irreplaceable in the North American market.

The Embraer 170 operator base is relatively thin compared with other members of the family but the type is seeing a new lease of life in the USA, flying for American Airlines as 65-seaters.

The best-selling E175 continues to sustain Embraer, making up about 50% of the entire commercial aircraft backlog. But the US concentration of global fleet is increasing.

The fact that no scope clause-compliant aircraft can replace E170/E175 fleets in the US means less volatile residual values, but at a much lower level now, observes a source.

Demand has picked up for CF34-10 engines, albeit in a limited market, but new and secondary operators such as Air Dolomiti, Sky High Aviation Services, United Nigeria and Congo Airways could boost demand, according to one source.

The CF34-10 is a relatively expensive engine considering the market and this has restricted appeal outside established players, adds the source.

The E190 model has probably been the most traded regional aircraft over the past two years. Supply has been mostly absorbed, with more than 50 aircraft placed at Alliance Airlines, Airlink and Breeze Airways alone, plus smaller numbers at carriers such as BA Cityflyer, Bamboo Airways and Cobham Aviation. Nevertheless, there is little doubt that between the abundance of E190s on the market and Covid-19, many of the E190s placed (not only in Australia) had an element of distress, which, in turn, helped stimulate the demand, says one source.

The PW150A market continues to be relatively quiet, compared with the PW127 engine models.

"As hot section inspections and life-limited parts costs are more manageable for turboprop engines than jets, and TBOs [time between overhauls] tend to be lower, the attractiveness of used engines is lower," says one pollster.

The PW150A is expensive to put through the shop at about $1.5 million to $1.6 million and the Q400 type has experienced difficulties in placement in the market. Some airlines have expressed interest in the type but their price expectation was lower than offers.

Production for the Dash 8-400 is still paused, with limited demand. The Flybe bankruptcy (54 aircraft) has not helped the type. When combined with Air Baltic, LGW, Austrian Airlines and SA Express phase-outs, a total of 90 units have been on the market looking for new homes.

The type is effectively retiring from the European markets and one source points out as many as 110 units, or more than 25% of the estimated 420-active fleet, include imminent retirements at Olympic Air and LOT Polish Airlines.

The secondary market demand has been very limited for the passenger side with several operators adding capacity while main trading has been aerial firefighting applications at Conair Aviation.

The PW127F engine ranked lower than last year. More airlines are moving to the ATR72-600 models but demand has in the meantime increased on the freighter side because conversions are now only for the ATR72-500 type.

The PW127 engine fleet is dominated by original equipment manufacturers and few players, observes one pollster. Growth in freight and inter-island services (on-going and expected) will support the fleet. Still, the types have a large number of aircraft in service and benefit from transitions to second- and third-tier operators.

LOT's ATR72-500s are still parked or stored, potentially with engines needing work. *Airfinance Journal*'s Fleet Tracker showed about 90 ATR72-500 units inactive in March 2022, while another 40 had been retired. Still, the ATR72-500 fleet accounted for more than 300 aircraft in service.

In 2021, 17 ATR72-500 passenger aircraft were converted into cargo. This compared with eight units before the Covid-19 pandemic. In addition, the manufacturer delivered four new ATR72-600Fs last year.

ATR is confident that this is a growing market because airlines operating for large integrators increased their flights substantially in 2021.

Regional engines

	Investor appeal	Remarketing potential	Residual value
CF34-8C (CRJs)	3.50	3.92	3.54
CF34-8E (E170/175)	4.29	4.57	4.25
CF34-10E (E190/195)	3.59	3.53	3.47
PW123 (Dash 8)	2.27	2.77	2.55
PW127E (ATR42-500)	3.00	3.38	3.33
PW127F (ATR72-500)	3.29	3.58	3.92
PW127M (ATR72-600)	4.13	4.46	4.58
PW150A (Q400)	3.25	3.42	3.71
PW1919 (E190/195-E2)	4.25	4.04	4.42

NB: Rating of 1 means lowest rating, 7 highest. *Source: Airfinance Journal* engine poll, March 2022

OEMs face inflation and supply headache

Original equipment manufacturers are pondering price escalation and a strained supply chain, writes **Laura Mueller**.

Just as the aviation market begins to recover from the crippling impact of Covid-19, an inflationary environment raises concerns about escalation and whether rates can be capped with original equipment manufacturers (OEMs) as in the past.

Pratt & Whitney's chief commercial officer and senior vice-president, Rick Deurloo, tells *Airfinance Journal* that OEMs, "like all others", are concerned about escalating prices of components and other supply inputs.

"On a scale of one to 10 in this calendar year 2022, it's probably in the seven to eight range as a concern," says Deurloo.

"I say that because we have two sides of this coin, one being our product cost; we have a supply chain where we need to keep our costs down and so there's natural tension around our suppliers and escalation at the same time. On the other side of that coin are our airline customers. This is a very long-cycle business, so escalation will play itself out through that," he adds.

Deurloo acknowledges that, in the "medium term", escalation is a headache.

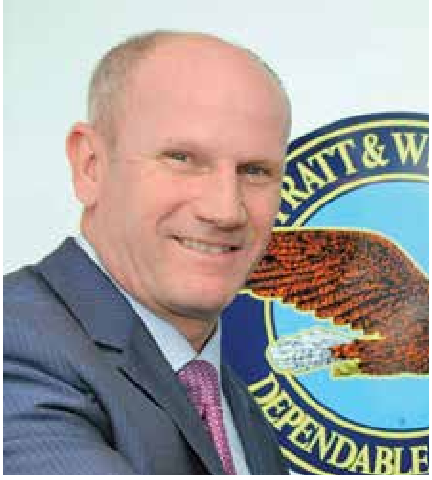
However, he notes airline customers "typically" have some form of escalation protection. "Many of these are under power-by-the-hour contracts or they have escalation protection lined up with their engine deliveries and spares."

Regarding the possible triggering of hyperinflation costs in an environment where the US Federal Reserve is tipped to embark on a string of rate rises, starting this spring, Deurloo says the OEM is not "overly concerned about breaking through" on those bans.

He adds: "It's still early in this inflation/escalation cycle, so we'll see. Contract escalation continues to be at the forefront of our conversations with our customers like it is with our suppliers. It's gonna be a pretty dynamic situation, I would say, in the next 12 months," adds Deurloo.

Deurloo dismisses concerns regarding Airbus's push to rate 70 based on demand, but acknowledges the supply chain will likely lead to output delays.

"The Airbus A320neo family and the A321XLR, in addition, have just done an incredible job in the marketplace and that demand is there. We see it, so there's no disputing the demand that Airbus talks about.



> We have the capacity in place right now for rate 63, we continue to have conversations with Airbus.

Rick Deurloo, chief commercial officer and senior vice-president, Pratt & Whitney

"On the flip side, and this is not with our industry, the global supply chain is under stress, whether it's workforce, whether it's raw materials, there are obvious supply chain challenges. When we talk to Airbus, we wonder how that supply chain will match up with their production rate desires," he says.

However, Deurloo is quick to point out that Pratt & Whitney produced at rate 63 in March 2020 until Covid-19 devastated the industry.

"So, we have the capacity in place right now to that rate 63, we continue to have conversations with Airbus and try to understand and align around the demand, which I think both Airbus and Pratt clearly see, and then how we have to manage our supply chains through this process," he says.

A lessor chief executive officer (CEO) speaking on condition of anonymity told *Airfinance Journal* that Airbus's desires to go to rate 70 is "wishful thinking".

He adds: "Airbus is already running two to four months behind on Airbus A321neo deliveries and many suppliers are choking to try to keep up with today's rates."

In a recent earnings call, MTU Aero Engines, which manufactures elements of the PW1100G and other engines, said it had not had any discussions with Airbus about moving to rate 70, but said it expected to do so this year.

On another recent earnings call, Aircastle's chief executive officer (CEO), Michael Inglese, said supply chain issues and market uncertainty will affect plans to raise output at aircraft manufacturers.

"They're going to try to go as fast as they can because they have a different business model. Will they be able to ramp to where they say they're going to go in the next two years? No," says Inglese.

"I don't think many people who don't work at Airbus or Boeing believe that, given what's going on in the world, and in the context of the supply chain," he adds.

Following the release of its orders and deliveries report, Airbus's CEO, Guillaume Faury, says he remains confident about the sustainable growth of air travel post-Covid-19.

He says that "while uncertainties remain", Airbus is on track to raise production rates through this year.

Last May, Airbus confirmed an average A320-family production rate of 45 aircraft a month in the fourth quarter of 2021 and called on suppliers to prepare for the future by securing a firm rate of 64 by the second quarter of 2023.

In anticipation of a continued recovery, Airbus is also asking suppliers to enable a scenario of rate 70 by the first quarter of 2024. Longer term, Airbus is investigating opportunities for rates as high as 75 by 2025.

Its main rival is targeting 31 Boeing 737 Max aircraft a month this year, and various media reports indicate the US manufacturer is investigating kicking up output to 42 in late 2022 and then possibly 50 aircraft.

Inglese says a ramp-up would not alter Aircastle's business plans.

"As Airbus sort of ramps up to start delivering, none of that is likely to change Aircastle's strategy or approach to the market," he says. "We've never been a big orderbook player."

Sustainability is lessors' top priority

Tom Barrett, Engine Lease Finance's president and chief executive officer, looks at the engine lessor's role in sustainability, post-pandemic consolidation and lessons for the future.

In 1990, when the engine leasing industry was in its infancy, the motivation for many of the developments in engine technology were around noise reduction rather than sustainability. The periodic increases/decreases of fuel costs were not enough for aviation to make a strong commitment to sustainability. There is no doubt now, in 2022, that it is sustainability and alternatives to current fuel consumption that is the predominant concern of engine manufacturers as they develop new technologies. Engine lessors must be ready to play a role in this, too.

Despite ongoing high infections and as countries get to the point of living with Covid, it is evident that a recovery in international travel and domestic networks is looking unstoppable for many regions in 2022. As the worst effects of the pandemic pass, now is an interesting time to consider what might be the prospects for consolidation in the engine leasing industry.

In this period of recovery, it is also appropriate to contemplate what the future of engine leasing might look like and to assess what has changed because of the pandemic. There is no doubt the pandemic did create the most difficult set of circumstances ever for this industry and you would therefore expect that it will have led to significant change.

Finally, the author reflects on what he predicted at the outset of the pandemic two years ago would be the consequences of this.

Sustainability

While aviation is a crucial part of the world economy, as has been seen over the past two years, the human connection made possible by aviation is maybe even more important. Cultures, communities and families exist best when human interaction is made possible, and aviation has a role to play in facilitating this interaction.

Having tried to ignore sustainability for many years, maybe because it feared the extra scrutiny that would come, the aviation leasing industry has woken up to the fact that it must play its part and be ready to take a lead in these discussions.

Industry bodies such as the Aviation Working Group and Aircraft Leasing Ireland are investing considerable time and effort in preparing coherent positions for and with their members. The urgency required is evident when you consider the UN Intergovernmental Agencies report published in April.

It is up to all participants, manufacturers, governments, equipment owners and the airlines to make sure that aviation's contribution to global warming is minimised as the world drives towards a sustainable future. The many initiatives ongoing include sustainable aviation fuels, hydrogen-powered aircraft, eVTOL and others, and they will all have a part to play.

It is vital that the engine leasing community supports all these initiatives and participates in a way that makes it easy for the more sustainable products to be adopted into their markets.

Some, such as Engine Lease Finance (ELFC), are focusing their investment strategies on the newest technology engines and aggressively pursuing the acquisition of such equipment by providing airlines with the opportunity to maximise their asset values with the lowest possible lease rates. It is by using their extremely low cost of funds that these lessors can contribute to the early adoption by many airlines of the new-technology equipment, thereby helping reduce fuel consumption immediately. Active support and participation around all these new initiatives will be crucial.

As this new technology begins to mature, it will be vital that the original equipment manufacturers (OEMs) and other independent industry participants create repair and other processes that can extend the life of these more fuel-efficient engines. Based on past experience, the use of independent maintenance, repair and overhauls (MROs) will accelerate this process and, once again, the lessors can play their part by being willing promoters and users of these repair technologies as they are introduced.

The role of established lessors is not confined to new technologies, and it is crucial that with more than 13,600 of current-technology narrowbody aircraft in service/storage that there is greater efficiency, re-use, and recycling of the current stock of aircraft and aircraft engines. This is another area where the engine lessors can play their part and make sure that they efficiently manage the assets, so that the assets can be re-used and recycled.

At ELFC, our in-house parts company, INAV, ensures that as many parts as are viable are repaired and ultimately recycled as used serviceable material.

It is through aggressive acquisition of new-technology equipment, support for all industry initiatives and maximising the repairs and recycling of current engines that engine lessors can play their part to support the sustainability agenda of the industry.

Consolidation

With the industry recovery and as an increasing number of aircraft lessors consolidate in 2022, is there scope for real consolidation within the engine leasing industry?

It states the obvious that with only 10 engine lessors of significance (those with 25 engines or more), the scope is limited.

The OEM-owned lessors, PWEL, RRPF and SES (Safran/Aercap joint venture), fulfill the OEM required roles of supporting their new engines' entry into service and their pool support for their existing programmes. They will inevitably continue this focus on their relevant OEM parent products and remain within their OEM family in one way or another.

Among the five or six significant independents, which now includes Aercap, most are focused on the very aggressive sale and leaseback business to ensure they can capture market share of the new technologies as they are adopted. Additionally, with lease rates on the new-technology engines being appreciably below the lowest aircraft lease rates and the competitive environment being such that full value is often paid for the engines, there is little room for more new entrants. Furthermore, all of these participants are well capitalised with owners which have very clear long-term objectives for their continued growth and investment.

The considerable risks around the entry into service issues and the challenges to compete with OEM-owned pool offerings has meant that speculative orders of new-technology engines have been few and, as such, with one notable exception, they have been avoided by the engine lessors, other than the OEM-owned ones which did so in order to support the OEM priorities.

If there is to be consolidation in the engine leasing market, it looks likely to come from speculative new entrants which are looking to exploit the perceived good value in engines as their host aircraft are retired. However, as has been seen in previous market shifts to new technology, this is a very short window and those participants will only succeed if they can create a platform that can switch to manage the equipment as those leases expire. In the past, this has proven elusive with more losers than winners in the 30-year lifespan of the engine leasing industry. History, in this regard, has a habit of repeating itself.

“At ELFC, our in-house parts company, INAV, ensures that as many parts as are viable are repaired and ultimately recycled as used serviceable material.”

Tom Barrett, president and chief executive officer, Engine Lease Finance

Having said that, the market remains a relatively small niche with few participants, yet it is price efficient and competitive and the low lease rates and competitive landscape for every sale and leaseback opportunity is solid evidence of this. All of the engine lessors are committed to the industry and will use their access to cheap funds to maintain their very aggressive approach to meet their growth targets while delivering superior commercial terms for their airline customers.

Future of engine leasing

Clearly, sustainability is going to be an important part of aviation for the future and there will be no room for lessors which cannot credibly articulate (for the benefit of the financing community and/or their shareholders) their role in the sustainability discussion going forward.

Some are attempting to see if engine securitisations can follow the aircraft industry but with engines being such a complex asset where so much value is wrapped up in maintenance condition, it is very difficult to see how engines can be commoditised to the same degree that aircraft have been over recent years.

The issue for engines is that so much of their value is wrapped up in maintenance relative to the cost of the asset and you must have flexibility when engaging with the customer regarding the outcomes at redelivery and through a cyclical downturn, as we have just seen.

It is for this reason that the strategy of pursuing an asset-backed securities (ABS)-type vehicle with engines is fraught with challenges and it is little wonder that through the current pandemic most of the engine ABSs have been failing to meet their obligations. This is a fact that seems to be underreported but is very relevant to how the industry is structured in the future.

Given that after 30 years there are fewer than 10 credible engine lessors, three of which are owned by the OEMs, and furthermore given that it is anticipated that new leased spare engine deliveries will be as few as 260 in the next three years, then it is to be expected that engine leasing will always remain a modest niche with fewer participants than for aircraft. In fact, this has in the past been one reason why many aircraft lessors have ignored it and it will be interesting to see how the current leading independent develops its strategy in the years to come.

Lessons from the pandemic

As we move further into 2022, it is fair to say that, despite several upsurges in infections, the world is readying itself for living with Covid in a way that will facilitate a strong recovery of aviation. Therefore, now is a good time for lessors to contemplate how to take the lessons

“It is fair to say that, despite several upsurges in infections, the world is readying itself for living with Covid in a way that will facilitate a strong recovery of aviation.”

of the past two years so they are ready to better manage the business in any future pandemic or similar crisis.

Operationally, one lesson of real significance was the fact that the IT available today allowed the lessors and the industry to operate. This was even though staff were working remotely, and all travel and visits were prohibited at various times.

While IT supported virtual interaction with customers, it was clear that the personal interactions, where creative solutions and collaboration could take place, were missed. Virtual interactions were enough to allow “crisis management” and some engagement with customers in a way that could provide flexible solutions to their immediate needs. However, these virtual interactions were not enough to allow a complete understanding of all the customers’ requirements in a way that ELFC, as an experienced lessor, could bring more innovative long-term solutions to their business.

With such a desperate period for our customers, a huge level of flexibility was required to support the industry. The level of flexibility ELFC could bring, which can be very difficult if all your assets are managed or secured in a complex ABS structure, was vital for our customers. We do not think it would have been possible to manage the customers’ requirements through the pandemic in the same way if all assets were in complex structures where investors’ requirements would have created potential conflict with the immediate needs of the customers.

In addition, flexibility would not have been possible were it not for the disciplined and aggressive write down of our assets during our period of ownership. The point here being that flexibility for customers was only possible because ELFC had aggressively written down its assets (did not reduce depreciation to make deals look good) and did not take unwarranted levels of maintenance lease payments to revenue without addressing the impact on the engine utilisation that remained after the revenue. ELFC’s prudent lease and asset management has benefitted our customers through this crisis.

After having provided a working solution for our staff and engaged with our customers to manage the crisis flexibly, the shareholders had to be fully briefed and in a position to support the enterprise through the worst of the pandemic. This support was crucial in allowing continuing delivery of profits and growth of the portfolio through the crisis. Without excellent lines of transparent and open communication, this would not have been possible.

With the inevitable increase in inventory, operations also had to be swiftly redirected to bring a more defined focus on short-term leasing. The outcome was the development of shop visit avoidance programmes with airline customers, flexible terms about lease tenor and utilisation expectations.

It is all of these factors and the emphasis that the entire company’s staff and experience brought to bear that leave us well placed to maintain this delivery for our customers, our staff and our shareholders into the future.

Pandemic predictions – what we got right and what we got wrong

At the time of writing an article for this publication in April 2020, we predicted there might be six consequences of the pandemic:

1. Significantly more sale and leaseback opportunities would be presented by the airlines as they sought to improve their liquidity;
2. New sale and leasebacks would provide stronger economic returns as the pandemic ran its course and the risks of aviation would be priced into the transactions;
3. Utilisation, which had stalled at the time of writing in April 2020, would take a considerable amount of time to recover;
4. Oversupply of spare engines brought about by this underutilisation and a massive reduction in MRO shop visits would ensue;
5. Lease rentals would fall dramatically because of this oversupply and there was some concern that power by the hour (PBH) might become the norm for all engine leasing; and
6. Significant decreases in engine values would follow.

Like any forecasts, there were mixed results, but it is worthwhile to reconsider these six predictions with the benefit of hindsight:

Continued on page 22

1. **Incorrect – new acquisition opportunities did not develop to the expected extent.**
   The reasons for this are many but it is my opinion that the lack of opportunities for sale and leaseback on engines was brought about in large part because the pandemic effects were so great that the benefits of a sale and leaseback were not enough to move the dial for the airlines. Instead, the pandemic effect was so dire that the airlines had to be supported by their respective governments.
   It is fair to say that where the airlines were not supported by their governments, many of the airlines failed or remain on the brink of failure even as the recovery is beginning to take hold. An increase in their sale and leaseback activity could never have provided enough liquidity to make the difference.
   The consequence of strong government support, where it was available, was that the airlines were able to recover much more quickly.
   It is obvious also that the lack of new deliveries also had a consequence on the ability to access new equipment sale and leasebacks.

2. **Incorrect – the economics of the sale and leasebacks did not improve for lessors.**
   The reasons for this would appear to be that there continues to be a significant amount of cash available to this industry and the interest rates are such that the lessors have been able to keep their offerings very aggressive.
   There is also evidence that some lessors are slashing their depreciation rates to justify the uneconomical returns that follow the low lease rentals that they are offering. As future cycles unfold, this may well prove to be a fatal decision.

3. **Correct – utilisation, which had collapsed, has taken some time to recover.**
   I think it is fair to say we were optimistic as to the tenor of the recovery. However, with the stored narrowbody aircraft having decreased by almost 50% over the past six months, and the anticipated demand over this summer in the northern hemisphere at least, the utilisation levels will begin to return to more normal levels in 2022.

4. **Correct – oversupply, with no activity of significance in 2020 and only modest activity in 2021, did occur.**
   Given the lack of utilisation mentioned above, there was very limited demand for spare engines and many airlines tried to develop shop visit avoidance programmes. It is difficult to predict when this period of oversupply will correct but with so much of the current-technology narrowbody fleet still to have their first shop visits, it does suggest the engine will come back into a period of equilibrium in 2023 or 2024.

5. **Correct – lease rentals did indeed collapse.**
   Indeed, for a short period, there were probably deals to be done with zero floor and PBH-only arrangements. However, after a relatively modest number of months, this offering disappeared from the market and most short-term leases now include at least a minimum floor and, in many cases, a premium. These levels of rental are, for those who have adequately written down their assets, providing commensurate return for the investment. In fact, it might be perceived as a decent return for those who picked up some of the cheaper assets on aircraft being retired during the pandemic.

6. **Incorrect – asset values did not collapse.**
   On asset values, while some engine types did experience decreases, most were found to hold up remarkably well, particularly for the newer- and later-build current-technology engines which support the more populous aircraft. However, this was only where those assets had good lease terms attached. The inventory (off-lease) asset did see a decrease in value, but it is evident from all the independent appraisers that the decrease in narrowbody current- and new-technology equipment is relatively small given the nature and extent of the pandemic.

Conclusion

In terms of priorities, sustainability must be the number one priority for anyone who is investing in engines in 2022. In the future, if there is not a credible strategy adopted, these entities will quickly find that it will be difficult to access competitive funding and their customers, and their shareholders, will be unwilling to support them with any growth in the years to come.

The industry will continue to be a relatively small niche with the number of strong players competing aggressively. All these companies manage very complex assets with relatively modest, compared to aircraft, carrying values. This will mean that it will remain extremely difficult for new entrants and therefore the population of engine leasing companies is unlikely to grow materially in the years to come.

The pandemic has created enormous problems for the world; the industry and the engine lessors are no different. However, as we embark on a period of recovery, it would be ELFC's view that many of the effects of the pandemic are like those that we have seen in previous (more regional) crises.

It gives us confidence that by continuing the disciplined approach to acquisition pricing, the long-term investment horizons necessary for good asset management, that the well-funded and structured engine lessors will be able to deliver through the future cyclical downturns that will inevitably come in this industry.

"In terms of priorities, sustainability must be the number one priority for anyone who is investing in engines in 2022."

Tom Barrett, president and chief executive officer, Engine Lease Finance

Evaluating the cost of **on-wing time**

Kane Ray, Kayan Aviation Group's manager, technical, looks at the fundamentals of engine time on-wing and its associated costs.

In this article, I am principally discussing corresponding cost metrics related to aircraft engines, each of which are linked, and influenced by their own factors too: engine US dollar per flight hour rate ($/EFH), engine life-limited part USD per engine flight cycle rate (LLP $/EFC) and the mean time between restoration/overhaul (MTBO).

The intention of the article is to display where these metrics find uses based on aircraft/engine appraisal assessments, and aircraft acquisition, how they can be interpreted to realise more value at acquisition and throughout a lease term.

In the present market, we find that rates and intervals linked to engines are a fundamental metric to being competitive or uncompetitive during acquisitions, and this places greater emphasis on their understanding and use.

When performing appraisals, the $/EFH was an indicator and estimated as a division of estimated shop visit cost by the MTBO. The requisite of being an engine appraiser were the relationships held with engine original equipment manufacturers (OEMs) and the guidance data provided on metrics such as the indicative $/EFH rate.

This information assisted with the sensitivities associated with providing an independent service, but how reflective it was with the asset being assessed was unclear, although targeted assumptions would be made given known information, which tended to be criteria such as the operator, likely operating environment, flight hour to flight cycle ratio and remaining LLP life.

Provision of information varied with each lessor/customer willing to or only having the ability to provide the appraiser with a snapshot of information to perform an appraisal. Ultimately, the $/EFH rate was associated to the estimated shop visit cost, rather than the specific rate that might have been apparent in the lease agreement for the engine.

Today, I find myself assessing the engine typically as part of the whole aircraft, in a role that ultimately contributes to a desired acquisition of aircraft. Our success tends to occur with mid-life assets, which are previous-generation technology, or put another way, no longer the production standard.

Table 1: Average maintenance reserve rates associated to a Boeing 737-800

Component	Annual Collection 2022	Proportion
Airframe 8yr	$86,000	8%
Airframe 10yr	$72,000	6%
Airframe 12yr	$78,000	7%
Engine Overhaul	$500,000	45%
Engine LLP	$290,000	26%
Landing Gear	$44,000	4%
APU	$41,000	4%
Total	**$1,111,000**	

Source: Kayan Aviation Group

Within this acquisition criteria, extended lease terms are sought, and inherently, this entails careful scrutinising of the engine condition for value because of the anticipated portion as a sum of the entire aircraft at lease end (for the engine, generally a share that increases as the aircraft ages).

Accessibility to information when assessing the aircraft is much improved in most cases given the willingness of a seller to transact with upfront transparency to avoid obstacles further along.

Further, the premise for buyers is that actual rates, or assumptions behind them (such as typical industry rates or average cost from operator quotes) enable confidence and accuracy during the assessment period. The assessment is also self-serving, particularly through the initial phases of a bidding and acquisition process, where you can forecast eventual scenarios with some flexibility on the likelihood of that occurring. The MTBO and $/EFH rate are both examples of assumptions you can diverge from the norm.

Emphasising why the engine assessment is crucial throughout the aircraft life, Table 1 depicts some average maintenance reserve rates associated to a Boeing 737-800, assuming 3,000 flight hours and 1,500 flight cycles a year. These estimates are based on typical 2022 escalation rates widely recognised.

For this 737-800 example, the engine's maintenance reserve share is just over 70%. Isolating the $/EFH rate, this can vary as addressed from the outset, but it can also vary while on-lease. For instance, the engine might operate at a different thrust rating and derate brought about because of the title engine (to the lease) is being utilised on another aircraft in an operator's fleet - think of United Airlines, its mix of 737-700/-800/-900/-900ER aircraft, consequent thrust ratings and expansive network.

In some cases, the rate can be broken down further depending on the initial detail of the lease. The breakdown occurs across the engine modules, and the cost portion is weighted towards the hot and high-pressure modules of the engine.

Table 2 details a representative example for a CFM International CFM56-7B engine.

Another factor of the $/EFH rate is what rate is adopted or agreed. For some aircraft leases, this is covered by the adoption of an industry rate applicable to the shop visit, or the reliance on several quotations from a licensed maintenance, repair and overhaul (MRO).

Less common is a rate set pre- and post-shop visit, but a blended (covering first and mature shop visit run eventualities) rate could be appropriate, although it is rarely made known.

Table 2: Representative example for a CFM56-7B engine

Module/Component	$/EFH Distribution %
Low Pressure Compressor	10%
High Pressure Compressor	24%
Combustor and High Pressure Turbine	48%
Low Pressure Turbine	16%
Gearbox	2%

Source: Kayan Aviation Group

Often, I interpret a rate applicable to a first run shop visit, which can be restrictive comparatively given the mature interval, subsequent shop visit cost and the condition-based residual value.

For shorter lease terms, this approach may be suitable, but for extended leases, this could leave a deficit if not negotiated or considered, especially as mature engine shop visits tend to be shorter than first run intervals. A caveat to this is that the rate could be linked to an OEM or MRO maintenance agreement with workscope guarantees, thus the concern/risk is nullified.

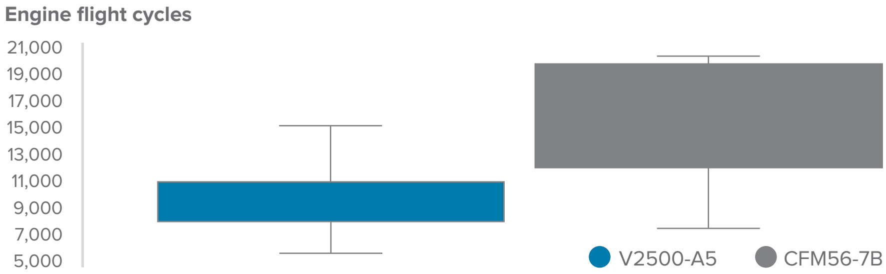
Less divergent is the LLP US dollar per engine flight cycle (LLP $/EFC), and this traditionally follows the OEM's annual rate. Owners may need to negate some life lost (stub life) in LLPs when it is more practical and economic to swap out LLPs at a heavy maintenance shop visit. This practice is common enough and is often determined by assuming 95% of the individual LLP cycle life and dividing it into the LLP part cost.

The total across all LLPs is then the rate. In rarer instances, a premium may be applied to the LLP current list price (CLP). Supporting the implementation of this stub life assumption, in a sample of 50 CFM56-7B engines that had had first run engine shop visits, the average interval was about 17,400 cycles.

If the CFM56-7B achieves 17,400 cycles on-wing (as above), the build standard will not be 2,600 cycles (HPC and HPT limits of 20,000 cycles) to run-out, because the potential interval following overhaul or restoration of a CFM56-7B far exceeds this, and could be linked to a used LLP insertion, or new LLP replacement.

Many engines trend towards a typical MTBO estimate, and OEM indications are dependable but might not give full clarity on the variables. An objective approach to arrive at an interval is possible given a set of criteria. Assuming a first run CFM56-7B engine, this could be the operator, thrust rating, aircraft it is attached to, etc, which consequently gives the country of operation and the ability to understand where the aircraft is regularly operating to and from, which could indicate how much engine derate might be being used. There are trends beyond the typical 1.7:1 flight hour to flight cycle ratio with an assumed derate.

Chart 1: Single-aisle engine first run shop visit parameters (flight cycles)



The first chart compares actual first run cyclic interval data for V2500-A5 and CFM56-7B engines.

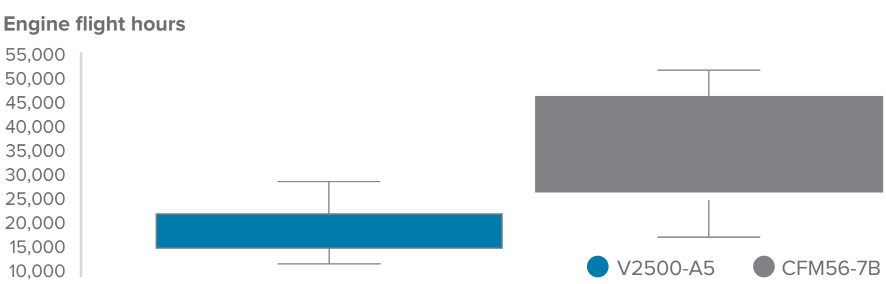
Cycles are almost always the chosen measure for engine maintenance, and this is because of LLP shop visit replacements that coincide with restorative maintenance in those LLP replacement modules. Looking at the V2500-A5 depiction, you can see that even with this portion of data compared with the total fleet, LLP replacements are more likely to fall at the second or third shop visit based on the timing of the first run visit, given LLP cycle limits of 20,000. Most first run shop visits will be classed as a high spool restoration rather than an overhaul and, for the majority, there is a concentration of when this occurs.

Another consideration for the V2500-A5 engine family are the numerous airworthiness directives that have impacted high-pressure module LLPs, such as the HPC 3-8 drum, HPT Stage 1 and Stage 2 Hub, and HPT air seals, and any consequent fixes could have had a negative impact on the achievable restoration/overhaul interval.

The CFM56-7B segment illustrates that a first run interval allows every chance of core LLP replacement and possibly LPT LLP replacement, particularly if the LPT requires a restoration/overhaul maintenance workscope. It also details that not all operating conditions enable a first run of 20,000 cycles. For later CFM56-7B/3s, and we assume the then later CFM56-7BE with optimum operating conditions, we do see these engines as running closest to 20,000 cycle LLP limits.

The second chart details the equivalent data but uses flight hours as the interval benchmark.

Chart 2: Single-aisle engine first run shop visit parameters (flight hours)



The flight hour depiction reveals much the same. On the CFM56-7B, a further revelation is perhaps the longevity of the engine when operating at larger flight hour to flight cycle ratios compared with OEM indications and V2500-A5 engines (note that in many of these instances with long on-wing time, first run engine shop visits included an LPT workscope). As with the cycle view, we again see that the V2500-A5 is more consolidated and managed around LLP replacements at the second shop visit.

As part of a future appraisal or lease assessment, the projected MTBO is vital because of consequent MTBOs, and primarily the cycle life remaining of LLPs, the workscope decisions taken when replacing them and the resulting achievable interval, and how this impacts the residual value.

Depending on the lease structure and the ability for the lessor actively to influence maintenance, this could enable a better maintenance reserve position at lease end and could be influential in adopting used LLPs and used module replacements as a cost saving and draw down measure.

Oppositely, having engine life at the end of lease might be sought to offer a better remarketing possibility, or independent to the host aircraft, as a spare engine.

Concluding, $/EFH and MTBOs are used by numerous individual's privy to the evaluation of an aircraft, typically on lease. The $/EFH structure within the lease is a critical influencer in the estimated return that can be generated on an asset transaction. Flexible options such as recognising current industry rates and alternating level shop visits help represent the irregularity to what occurs through the engine's life, given operational and market variables.

In many instances, $/EFH rates in leases multiplied by typical MTBOs, do not correlate to OEM shop visit cost estimates meaning that future negotiation or lessor top-up could be necessary. Such rates are perhaps best suited to engines that will follow the conventional maintenance programme as desired by the OEMs, where the engine can be maintained for its highest and best use – ie, built for the intended and longest possible time on-wing.

Engine maintenance to benefit from MRO recovery

MRO is on the road to recovery with pre-pandemic levels expected by next year.

As airlines continue to support their growth with the reintroduction of their fleets, engine maintenance is set to be the biggest driver in air transport maintenance repair and overall (MRO) over the next few years.

Naveo Consultancy anticipates the MRO industry will return to pre-pandemic levels by 2023.

According to its analysis, the MRO industry is set for $84 billion-worth of expenditure in 2022, up from $72 billion in 2021. By 2023, it will exceed pre-pandemic levels with $97 billion in revenues forecasted.

Naveo notes that MRO activity tends to evolve over the aircraft lifecycle.

"The introduction of a new aircraft type provides operators with the chance to change their maintenance behaviour, and this was seen as operators with 787s, A350XWBs, GTFs, LEAPs embraced outsourced maintenance offerings. OEMs [original equipment manufacturers], MRO integrators and independent suppliers each have their own strengths and challenges, but choice, flexibility and customisation are the name of the game. They help to leverage workscope management, used serviceable material [USM], part repairs and, to varying degrees, big data analytics," says the consultancy.

Naveo observes suppliers battling for positions to support aircraft, from entry into service through to retirement and tear-down, while OEMs, integrators, airline MROs, independent MROs and parts traders are attempting to extend their reach across the lifecycle.

"As aircraft age, operators become more price-sensitive and may embrace alternatives to traditional new parts or MRO," it says.

With the pandemic airlines have focused on fleet management and costs and embraced USM, pooling, greentime engine management and tailored workscopes, states Naveo.

Engine maintenance is anticipated to grow next year with a forecast of $7 billion more (to $37 billion) compared with 2021. Pre-pandemic levels showed $42 billion of engine maintenance spend.

After years of impressive aftermarket growth, the 2020 MRO market was down about 35% despite a solid first quarter as airlines grounded most of their fleets by the start of the second quarter.

In 2022, engine component and line maintenance are expected to grow with anticipated revenues of $17 billion each. Modifications and heavy airframe work are forecast to be relatively flat.

The consultancy says that the impact on the different types of MRO activity varied depending on the levers that airlines can pull to reduce expense.

"As airlines are in cash conservation, where possible operators will consider using greentime engines in-lieu of an immediate shop visit, USMs, or DER repairs," it adds.

Naveo expects the MRO market to grow by $25 billion in revenues and reach $97 billion by 2023.

By then, engine maintenance will account for $47 billion, or 48.5% of the total revenues, in line with 2019, when it was $42 billion.

Fewer retirements

There will be increasing retirements of ageing aircraft that need heavy airframe checks or third or fourth engine shop visits, predicts Naveo. The consultancy says almost 700 aircraft were retired from service in 2020, with an average age of 23.5 years.

Although the level of aircraft retirements last year was not as high as initially anticipated, it matched the level of retirements in 2018 and 2019, adds the consultancy.

Airlines are actively flying their youngest, most efficient and right-sized aircraft.

"Airlines and lessors prefer to wait and see how traffic (and residual values) recover," it says.

As a percentage of the active fleet, retirements have typically hovered between 1.7% and 3.4%, with an average rate of 2.5% a year. In 2020, the average retirement rate was 2.7% of the active fleet.

In 2020, about 175 retirements were widebodies, with the 747 model accounting for almost one-third. Airbus A320-family and Boeing 737NG retirements represented about 200 aircraft (or 28.5% of the total fleet), according to the firm.

The consultancy estimates that about 429 aircraft retired last year and points out that the 2021 retirements were below the 20-year average of approximately 624 retirements per year. In 2021, the average retirement rate was 1.5% of the active fleet.

"This means that there hasn't been a flood of USM to compete with OEM spares, and this also helps USM pricing of existing inventory."

Almost half of last year's retirements were Boeing and Airbus narrowbodies.

Of the 95 737NGs retired over the past two years, 68 were 737-600/700s, smaller aircraft and less popular than the larger 737-800s. These aircraft were typically harvested for their engines and components, which share commonality with larger 737-800s.

Of the 278 A320ceo family retired since 2020, 117 were the smaller A318/A319, and 137 were A320s.

The firm observes that many of these aircraft were acquired by private equity-backed USM providers for teardown, engine green time leasing, and part reclamation.

Higher jet fuel costs

Naveo says a higher-price jet fuel environment will continue to pressure airlines to retire less-efficient aircraft.

Jet fuel prices have edged up since the trough in April 2021 ($0.60 a gallon) caused by global lockdowns and 80% of air transport aircraft being grounded. By mid-October 2021, it reached $2.36 – the highest level for seven years, although it fell back towards the end of the year.

Since the turn of the year, the price of jet fuel has shot up, reaching $3.84 per gallon as of the end of March.

IATA predicted a jet fuel price average at $119 a barrel for 2022 at mid-March. It estimates that the impact of the 2022 fuel bill is $93 billion.

"If fuel prices remain high, we expect this to put pressure on aircraft retirements as it did in 2008," says Naveo.

The consultancy estimates that about 65 aircraft had been retired by mid-March.

There will be increasing retirements of ageing aircraft that would need heavy airframe checks or third/fourth engine shop visits, says Naveo. It adds that retirements also depends upon the pace of the recovery, fuel price, new aircraft production issues being addressed.

Airlines continue their cash conservation strategy. Where possible, operators will consider using green-time engines in-lieu of an immediate shop visit, USM, or DER repairs, says the consultancy.

Aircraft retirements reduce MRO expenditure for operators and owners but, in turn, impact revenues for OEMs and maintenance providers.

Thrust 2021-1 and West VI show appetite for engine ABS deals

Last year's engine ABS transactions, in the wake of the Covid pandemic, featured new enhancements.

Two engine asset-backed securitisations (ABS) hit the market in 2021 and reflected a number of enhancements to improve the resiliency of the transactions, which were not common in pre-Covid deals, including a collections test, a minimum number of assets test and more reactive DSCR tests.

Thrust 2021-1 is serviced by GE Capital Aviation Services (GECAS), which has been the servicer for multiple aircraft and aircraft engine ABS transactions. Proceeds from the notes are used to acquire 24 aircraft engines from White Oak Commercial Aviation Holdco, White Oak Commercial Aviation and White Oak Commercial Aviation II, or its affiliates.

White Oak Commercial Aviation, through certain affiliates, retains initially a portion of the $25 million series-C notes (86.6% loan to value) and the full amount of equity. That tranche priced at 7.39% coupon.

At the time of the launch (May 2021), the weighted average life were 5.2 years for the A and B notes, and 3.9 years for the C tranche.

The $485 million three-tranche engine securitisation transaction Thrust 2021-1 priced at 4.16% coupon on the senior tranche.

This represented a 4.2% yield on the $385 million of series-A notes, which have a 68.8% loan to value (LTV).

The ABS deal launched via issuers Thrust Engine Leasing 2021 DAC and Thrust Engine Leasing 2021 Statutory Trust.

The $75 million series-B notes, which have an 82.2% LTV, priced at 6.12% coupon.

Mizuho Securities USA is the structuring agent in the transaction. Jefferies Financial Group is joint lead in the transaction. Natixis SA, acting through its New York branch, is the liquidity facility provider.

KBRA assigned ratings of A, BBB, BB, respectively, to the three series of notes.

As of 31 March 2021, 21 of the 24 assets (91.6% by value) are on lease to General Electric Company, an affiliate of GECAS, two assets (4.8% by value) are on lease to Asiana Airlines and one asset (3.6% by value) is off-lease.

The weighted average remaining term of the initial lease contracts is about 5.8 years.

The initial portfolio consists of three engine types:

- Phase I GEnx-1B that power the Boeing 787 aircraft (61.1% by value);

- Phase II GE90 that power the 777 aircraft (34.1% by value); and
- Phase III Rolls-Royce Trent 970 that power the Airbus A380 aircraft (4.8% by value).

KBRA noted that the majority of the engines in the portfolio are Phase I and Phase II and have stronger near-term re-leasing prospects.

The portfolio contained two Rolls-Royce Trent 900 engines that KBRA believes are in the latter stage of their lifecycle in relation to their host aircraft (A380) and, as such, are classified as Phase III engines.

The transaction contained several features that have not been observed before. If there are fewer than 15 engines on lease to General Electric (360 days after the closing date), the issuer will be required to redeem the notes in full.

If there are fewer than five engines in the portfolio, the transaction will trigger a rapid amortisation event where any excess cash will be used to pay down the A notes and then the B notes, sequentially (after scheduled principal).

The liquidity facility in this transaction was sized to 18 months of interest on the A notes and B notes, which is the longest liquidity facility in any aviation ABS transaction rated by KBRA, compared with typically nine months of interest on the senior series of notes.

It also includes certain structural enhancements that are not included in most aviation ABS transactions:

- the debt-service coverage ratio (DSCR) is calculated off a three-month lookback window of cash flows compared with other aviation ABS transactions that use a six-month window. The three-month calculation will both trigger and cure the DSCR test earlier than a six-month window;
- excess amounts, if any, on deposit will be used to cover senior expenses, interest and scheduled principal on the A notes and B notes, and cannot be leaked to equity. KBRA points out that none of the initial leases are required to provide cash security deposits and the account will not be funded at closing;
- disposition paydown amount: sales will need to be paid back at 110% of the allocable series amount and 110% of the net sales proceeds compared with 105% and 100%, respectively, in most other aviation ABS transactions;
- the anticipated repayment date (ARD) is six years from the closing date, which is shorter than typical aviation ABS transactions. Typically, aviation ABS transactions feature a seven- or eight-year ARD;
- the maintenance look-forward in this transaction will increase from 12 months to 24 months after the ARD, which is one of the longer look-forwards compared with other KBRA-rated aviation ABS transactions; and
- the series-C reserve account is funded with $1 million on the closing date and will be sized to six months of interest on the series-C notes. If the amount in this account falls below six months of interest on the C notes, the account will be topped up in the waterfall. In other KBRA-rated transactions, the series-C reserve, if any, typically does not replenish.

West VI, Willis Engine Securitization Trust (West), represented the lessor-sponsored seventh issuance.

As per previous transactions, Willis retained the equity portion.

The West VI $336.7 million asset-backed securities transaction priced at a fixed coupon of 3.104% on the senior tranche.

The yield was 3.125%. The series-A notes to be issued total $278.6 million. The $38.7 million B notes priced at 5.438% with a yield at 5.5%. Both tranches had an expected maturity of eight years and a 6.9 years expected weighted average life.

The C notes, which amount to $19.4 million, priced at 7.385%. The notes had an expected maturity of eight years, and an expected weighted average life of four years.

BofA Securities and MUFG Securities Americas acted as structuring agents in the transaction.

MUFG Securities and Wells Fargo Securities were joint leads, while Bank of America was the liquidity provider.

KBRA rated the three-tranche transaction as A, BBB and BB, respectively.

Proceeds from the notes are used to acquire 29 aircraft engines and one airframe, a 2006-vintage A319 leased to Easyjet through July 2022.

Willis Lease Finance's sponsored ABS contained several components that have not featured in any KBRA-rated aviation ABS transactions.

One such feature is a collections test. If on a single-payment date rent collections are less than 75% of what is due, the amount of the scheduled principal due for the series-B notes on that payment date will first pay down the series-A notes and that same amount, if available, will pay down the series-B notes from remaining cash.

There is also a minimum number of asset tests. If the issuer does not own at least eight assets, and the outstanding principal balance is lower than one-third of the initial allocable notional amount of all series multiplied by the associated scheduled series percentage, then the transaction will begin to use any excess cash to pay down series-A notes and then the series-B notes, sequentially.

This transaction also includes certain structural enhancements observed in the Thrust 2021-1 ABS.

One enhancement is a three-month DSCR test compared with other aviation ABS transactions that use a six-month window. The three-month calculation will both trigger and cure the DSCR test earlier than a six-month window.

There is also a security deposit account. This account will be funded with 100% of the cash security deposits associated with the initial leases that expire before the ARD. Excess amounts on deposit will be used to cover shortfalls of senior expenses, principal, senior hedge payments and interest on the series-A notes and series-B notes and cannot be leaked to equity.

There is also a series-C reserve account. West VI will feature a reserve account of $1 million, which will be used to cover shortfalls in interest and principal for the series-C notes. In the event that the amount on deposit is less than $1 million, the series-C reserve account will be replenished in the waterfall.

West VI's initial LTVs are similar to West V, the $366 million engine ABS that closed in March 2020. The series-A notes have a 72% LTV while the B and C notes have 82% and 87% LTVs, respectively.

Portfolio

A total of 27 assets of those 30 assets are on lease to 10 lessees with three aircraft engines (10.5% by value) off-lease, for which no lease revenue was assumed throughout the transaction.

The portfolio had a weighted average remaining lease term of about five years excluding the three off-lease assets (one LEAP-1A, one LEAP-1B and a CFM56-7B), or 4.4 years, excluding the off-lease assets, leases with a letter of intent but not executed, and signed leases that have not been delivered.

This represented the longest lease term among the previous KBRA-rated Willis transactions.

KBRA noted that all of the engines in the portfolio are comprised of Phase I (77.1% by value) and Phase II (21.8% by value) engines that have stronger near-term re-leasing prospects, and it views such composition as a credit positive.

Engines considered Phase III engines could experience weaker re-leasing prospects than engines in an earlier stage of their lifecycle, which are typically designated as Phase I or Phase II engines.

The initial portfolio consists of a variety of engines that power narrowbody aircraft (79.3% by value), widebody aircraft (16.3% by value) and regional jet aircraft (3.4% by value), as well as the A319 airframe (1% by value).

The top three lessees comprised about 63.5% of the portfolio by value, and include SAS, IAE and Pratt & Whitney.

OEM	Engine	Fair Market Value ($m)	Base Value ($m)	Monthly Rental ($000)	QEC Value Range ($m)	LLP Cost (Est New) ($m)	Overhaul (ex. LLP) ($m)	MTBO	FH:FC
CFM	CFM56-3B1	$0.30	$0.30	$19,000	$0.025-$0.080	$4.00	$1.40	5,000	1.4
CFM	CFM56-3B2	$0.40	$0.40	$20,000	$0.025-$0.080	$4.00	$1.40	5,000	1.4
CFM	CFM56-3C1 - 23.5k	$0.60	$0.60	$25,000	$0.025-$0.080	$4.00	$1.50	7,000	1.4
CFM	CFM56-7B22	$3.00	$3.10	$42,000	$0.600-$1.800	$4.60	$3.30	21,100	1.8
CFM	CFM56-7B24	$3.50	$3.70	$48,000	$0.600-$1.800	$4.60	$3.30	21,100	1.8
CFM	CFM56-7B26	$4.00	$4.20	$54,000	$0.600-$1.800	$4.60	$3.30	19,050	1.8
CFM	CFM56-7B24E	$6.30	$6.70	$52,000	$0.600-$1.800	$4.60	$3.60	23,150	1.8
CFM	CFM56-7B26E	$7.10	$7.60	$56,000	$0.600-$1.800	$4.60	$3.60	20,600	1.8
CFM	CFM56-7B27E	$7.40	$7.90	$60,000	$0.600-$1.800	$4.60	$3.60	18,650	1.8
CFM	CFM56-5B5/P	$2.80	$3.10	$44,000	$0.800-$1.200	$4.80	$3.30	13,400	1.7
CFM	CFM56-5B4/P	$3.90	$4.20	$40,000	$0.800-$1.200	$4.80	$3.30	14,400	1.7
CFM	CFM56-5B4/3 PIP	$6.20	$6.70	$42,000	$0.800-$1.200	$4.80	$3.60	16,500	1.7
CFM	CFM56-5B3/P	$4.30	$4.60	$42,000	$0.800-$1.200	$4.80	$3.30	15,450	1.7
CFM	CFM56-5B3/3 PIP	$6.80	$7.30	$44,000	$0.800-$1.200	$4.80	$3.60	18,550	1.7
CFM	LEAP-1A26	$9.70	$9.90	$86,000	$1.500-$5.640	$5.50	$4.50	20,000	1.7
CFM	LEAP-1A32	$11.00	$11.20	$92,000	$1.500-$5.640	$5.50	$4.50	20,000	1.7
CFM	LEAP-1B27	$10.70	$11.10	$87,000	$1.600	$5.00	$4.60	21,000	1.8
CFM	LEAP-1B28B1	$11.20	$11.60	$89,000	$1.600	$5.00	$4.60	19,500	1.8
GE	CF34-3B1	$0.70	$0.90	$20,000	$0.185-$0.800	$2.10	$1.10	11,500	1.3
GE	CF34-8C5	$2.20	$2.70	$36,000	$0.550-$0.900	$3.30	$1.50	9,500	1.3
GE	CF34-8E5	$2.90	$3.10	$38,000	$0.550-$0.900	$3.30	$1.50	9,500	1.3
GE	CF34-10E6	$3.90	$4.80	$55,000	$0.800-$1.900	$2.80	$2.60	10,700	1.3
GE	CF6-80C2B6F	$2.50	$2.10	$70,000	$0.300-$0.800	$9.00	$4.50	21,500	6.0
GE	GEnx-1B74/75/P2	$19.90	$20.70	$190,000	$1.960-$3.600	$11.30	$7.30	19,500	6.0
GE	CF6-80E1A3	$4.00	$8.70	$70,000	$1.200-$1.824	$13.10	$5.00	19,000	6.0
GE	GE90-115BL	$9.80	$14.20	$90,000	$0.700-$2.100	$14.50	$12.00	30,000	7.5
GE	CF6-80C2B1F	$2.00	$1.70	$60,000	$0.300-$0.800	$9.00	$4.50	21,500	6.0
IAE	V2527-A5	$4.00	$4.20	$52,000	$0.700-$2.000	$4.80	$4.20	19,800	1.7
IAE	V2527-A5 Select	$5.30	$5.40	$58,000	$0.700-$2.000	$4.80	$4.20	23,900	1.7
IAE	V2533-A5	$4.80	$5.00	$55,000	$0.700-$2.000	$4.80	$4.20	14,500	1.7
IAE	V2533-A5 Select	$6.30	$6.50	$60,000	$0.700-$2.000	$4.80	$4.20	17,300	1.7
PW	PW4060	$2.50	$1.90	$53,000	$0.300-$1.800	$9.00	$5.70	18,200	6.0
PW	PW4168A	$3.10	$3.40	$60,000	$0.500-$1.200	$11.20	$7.40	18,200	6.0
PW	PW4090	$2.50	$4.30	$55,000	$1.000-$2.500	$18.50	$14.00	19,000	7.0
PW	PW1127G	$9.50	$9.70	$80,000	$1.800-$2.500	$5.00	$3.70	15,100	3.1
PW	PW1133G	$10.90	$11.10	$90,000	$1.800-$2.500	$5.00	$3.70	17,300	1.7
PW	PW1519G	$7.00	$7.20	$79,000	$1.800-$2.500	$3.20	$3.40	N/A	N/A
PW	PW1524G	$8.60	$8.80	$84,000	$1.800-$2.500	$3.20	$3.40	N/A	N/A
PW	PW1919G	$7.50	$7.60	$79,000	$1.800-$2.500	$3.20	$3.40	N/A	N/A
RR	RB211-535E4	$2.40	$2.60	$35,000	$0.225-$0.900	$7.00	$5.20	22,000	3.1
RR	Trent 1000-J2	$16.60	$17.30	$163,000	N/A	$8.70	$8.10	25,500	6.9
RR	Trent 772B-60EP	$4.90	$8.10	$50,000	$1.000-$2.000	$11.00	$10.30	26,200	4.4
RR	Trent 895	$2.60	$5.00	$60,000	NA	$13.60	$10.30	20,600	5.5
RR	Trent XWB-84	$22.90	$22.90	$220,000	N/A	$9.10	$8.60	21,000	6.9
RR	RB211-524H-T	$1.10	$1.40	$22,000	$0.125-$0.900	$6.50	$7.00	25,250	6.5
RR	Trent 970	$3.80	$3.80	$90,000	$0.600	$12.00	$8.10	25,200	8.8
RR	Trent 7000-68	$17.80	$17.80	$191,000	$0.650	$9.00	$8.10	21,500	4.7

Source: IBA, April 2022

Aircraft Model	Engine Options
1900C	PT6A-65B
1900D	PT6A-67D
340A	CT7-5A2
340B	CT7-9B
717-200	BR700-715A1-30
	BR700-715C1-30
737-10	LEAP-1B28
737-300	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
737-300QC	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
737-300SF	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
737-400	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
737-400SF	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
737-500	CFM56-3B1
	CFM56-3C1
737-600	CFM56-7B20
737-7	LEAP-1B25
737-700	CFM56-7B20
	CFM56-7B22
	CFM56-7B22/3
	CFM56-7B22E
	CFM56-7B22E3
	CFM56-7B24
	CFM56-7B24/3
	CFM56-7B24E
	CFM56-7B26
	CFM56-7B26E
737-700P2F	CFM56-7B22
737-8	LEAP-1B25
	LEAP-1B27
	LEAP-1B28
737-800	CFM56-7B24
	CFM56-7B24/3
	CFM56-7B24E
	CFM56-7B26
	CFM56-7B26/3
	CFM56-7B26/B1
	CFM56-7B26E
	CFM56-7B27
	CFM56-7B27/3
	CFM56-7B27/3B1
	CFM56-7B27/3B1F
	CFM56-7B27/B1
	CFM56-7B27E
737-800P2F	CFM56-7B24
	CFM56-7B24E
	CFM56-7B26
	CFM56-7B26E
	CFM56-7B27
	CFM56-7B27/B1
737-9	LEAP-1B27
	LEAP-1B28
737-900	CFM56-7B24
	CFM56-7B26
737-900ER	CFM56-7B26/3
	CFM56-7B26E
	CFM56-7B27
	CFM56-7B27/3
	CFM56-7B27/B1
	CFM56-7B27E
737BBJ1	CFM56-7B27
	CFM56-7B27/3
	CFM56-7B27/3B1
	CFM56-7B27E
737BBJ2	CFM56-7B27
737BBJ3	CFM56-7B27
737MAXBBJ1	LEAP-1B28
737MAXBBJ2	LEAP-1B28
737MAXBBJ3	LEAP-1B28
747-200F	CF6-50E2
	JT9D-7F
	JT9D-7R4G2
	RB211-524D4
747-400	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	RB211-524G/H-T
747-400BCF	CF6-80C2B1F
	PW4056
747-400ERF	CF6-80C2B1F
	CF6-80C2B5F
	PW4062
	PW4062-3
	PW4062A
747-400F	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	RB211-524G/H-T
	RB211-524H2
	RB211-524H2T-19

Aircraft Model	Engine Options
	RB211-524HT
747-400SF	CF6-80C2B1F
	PW4056
747-400LCF	PW4056
747-400M	CF6-80C2B1F
747-8	GENX-2B67
	GENX-2B67B
747-8F	GENX-2B67
757-200	PW2037
	PW2040
	RB211-535C
	RB211-535E4
	RB211-535E4-B
757-200PCF	PW2037
	RB211-535E4
757-200PF	PW2040
	RB211-535E4
757-200SF	PW2037
	PW2037M
	PW2040
	RB211-535C
	RB211-535E4
	RB211-535E4-B
757-300	PW2040
	RB211-535E4-B
	RB211-535E4-C
767-200ER	CF6-80C2
	CF6-80C2B4F
	CF6-80C2B6F
	JT9D-7R4D
	JT9D-7R4E
767-200ERF	CF6-80A2
	CF6-80C2B2
	CF6-80C2B4F
767-200F	CF6-80A
	CF6-80A2
	CF6-80C2B2F
	JT9D-7R4D
767-300	CF6-80C2B2F
767-300ER	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7F
	PW4052
	PW4056
	PW4060
	PW4060-1/3
	PW4060-3
	PW4062
	RB211-524H
	RB211-524HT
767-300ERF	CF6-80C2B6F
	CF6-80C2B7F
767-300ERP2F	CF6-80C2B2
	CF6-80C2B5F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
	PW4060
	PW4060-3
	PW4062
767-400ER	CF6-80C2B8F
	CF6-80C2B8FG01
777-200ER	GE90-85B
	GE90-90B
	GE90-92B
	GE90-94B
	PW4090
	TRENT 884
	TRENT 884-17
	TRENT 892-17
	TRENT 892B
	TRENT 892B-17
	TRENT 895
	TRENT 895-17
777-200LR	GE90-110B1
	GE90-115B
777-200LRF	GE90-110B1
	GE90-115B
777-300	TRENT 892-17
	TRENT 892B
	TRENT 892B-17
777-300ER	GE90-115B
777-8	GE9X
777-9	GE9X-105B1A
787-10	GENX-1B74
	GENX-1B76
	TRENT 1000-J3
	TRENT 1000-TEN
787-8	GENX-1B64
	GENX-1B67
	GENX-1B70
	TRENT 1000-A
	TRENT 1000-D
	TRENT 1000-D2
	TRENT 1000-G
	TRENT 1000-G2
	TRENT 1000-G3
	TRENT 1000-TEN

Aircraft Model	Engine Options
787-9	GENX-1B64
	GENX-1B70
	GENX-1B74
	GENX-1B76
	TRENT 1000-J
	TRENT 1000-J2
	TRENT 1000-J3
	TRENT 1000-K
	TRENT 1000-K2
	TRENT 1000-TEN
A220-100	PW1519G
	PW1521GA
	PW1524G
A220-300	PW1521G-3
	PW1524G-3
A300-600	CF6-80C2A3
A300-600R	CF6-80C2A5
	CF6-80C2A5F
	PW4158
A300-600RF	CF6-80C2A5
	CF6-80C2A5F
	PW4158
A310-300	CF6-80C2A2
	PW4152
	PW4156A
A310-300F	CF6-80C2A2
	CF6-80C2A8
A318-100	CFM56-5B8/3
	CFM56-5B8/P
A318CJ	CFM56-5B9/3
	CFM56-5B9/P
A319-100	CFM56-5A4
	CFM56-5A5
	CFM56-5A5/F
	CFM56-5B5/3
	CFM56-5B5/P
	CFM56-5B6/2P
	CFM56-5B6/3
	CFM56-5B6/P
	CFM56-5B7/3
	CFM56-5B7/P
	V2522-A5
	V2524-A5
	V2527M-A5
A319CJ	CFM56-5B5/P
	CFM56-5B7/3
	CFM56-5B7/P
	LEAP-1A26CJ
	V2527M-A5
A319neo	LEAP-1A24
	LEAP-1A26
	PW1124G-JM
A320-200	CFM56-5A1
	CFM56-5A3
	CFM56-5B3/3
	CFM56-5B4
	CFM56-5B4/2P
	CFM56-5B4/3
	CFM56-5B4/P
	CFM56-5B6/3
	CFM56-5B6/P
	V2500-A1
	V2527-A5
	V2527E-A5
A320CJ	CFM56-5B4/3
	LEAP-1A26CJ
	V2527-A5
A320neo	LEAP-1A24
	LEAP-1A26
	LEAP-1A26E1
	LEAP-1A29
	LEAP-1A32
	PW1124G1-JM
	PW1127G1-JM
	PW1127GA-JM
	PW1127G-JM
	PW1129G-JM
A321-100	CFM56-5B1
	CFM56-5B1/P
	V2530-A5
A321-200	CFM56-5B1/3
	CFM56-5B1/P
	CFM56-5B2/3
	CFM56-5B2/P
	CFM56-5B3/3
	CFM56-5B3/3B1
	CFM56-5B3/P
	V2530-A5
	V2533-A5
A321-200P2F	CFM56-5B3/2P
	CFM56-5B3/P
	V2533-A5
A321CJ	CFM56-5B3/3
A321neo	LEAP-1A32
	LEAP-1A33
	PW1130G-JM
	PW1133GA-JM
	PW1133G-JM
A321neoACF	LEAP-1A30
	LEAP-1A32

Source: Avitas, April 2022

Aircraft Model	Engine Options
	LEAP-1A33
	PW1130G-JM
	PW1133GA-JM
	PW1133G-JM
A321XLR	LEAP-1A32
	LEAP-1A33
	PW1133G-JM
A330-200	CF6-80E1A3
	CF6-80E1A4
	CF6-80E1A4B
	PW4168A
	PW4168A-1D
	PW4170
	TRENT 772B-60
	TRENT 772C-60
A330-200CJ	TRENT 772B-60
A330-200F	PW4168A
	TRENT 772B-60
A330-200P2F	TRENT 772B-60
A330-300 HW	CF6-80E1A3
	CF6-80E1A4
	CF6-80E1A4B
	PW4168A
	PW4168A-1D
	PW4170
	TRENT 768-60
	TRENT 772-60
	TRENT 772B-60
	TRENT 772C-60
A330-300 LW	PW4168
	TRENT 768-60
A330-300P2F	PW4168
	TRENT 772B-60
	TRENT 772C-60
A330-800	TRENT 7000-72
A330-900	TRENT 7000-72
A340-200	CFM56-5C2
	CFM56-5C4
A340-300	CFM56-5C2
	CFM56-5C3
	CFM56-5C3/F
	CFM56-5C4
	CFM56-5C4/P
A340-300CJ	CFM56-5C4
A340-500	TRENT 556-61
A340-600	TRENT 556-61
	TRENT 556A2-61
A350-1000	TRENT XWB-97
A350-900	TRENT XWB-75
	TRENT XWB-84
A350-900CJ	TRENT XWB-84
A350-900F	TRENT XWB-97
A380-800	GP7270
	GP7270E
	TRENT 970-84
	TRENT 972-84
	TRENT 972E-84
ARJ21-700	CF34-10A
ATP Freighter	PW126
	PW126A
ATR 42-300	PW120
ATR 42-300F	PW120
ATR 42-320	PW121
ATR 42-320F	PW121
ATR 42-500	PW127E
	PW127M
ATR 42-600	PW127M
ATR 72-200	PW124B
	PW127F
ATR 72-200F	PW124B
	PW127F
ATR 72-500	PW127F
	PW127M
ATR 72-500F	PW127F
	PW127M
ATR 72-600	PW127M
	PW127N
	PW127XT-M
ATR 72-600F	PW127M
AVRO RJ100	LF507-1F
	LF507-1H
AVRO RJ70	LF507-1H
AVRO RJ85	LF507-1F
	LF507-1H
BAE 146-100	ALF502R-5
BAE 146-200	ALF502R-5
BAE 146-300	ALF502R-5
C-212-100	TPE331-5-251C
C-212-200	TPE331-10-511C
	TPE331-10-512C
	TPE331-10R-511C
	TPE331-10R-512C
	TPE331-10R-514C
C-212-300	TPE331-10R-511C
	TPE331-10R-513C
C-212-400	TPE331-12JR-701C
C919	LEAP-1C
CRJ-1000ER	CF34-8C5A1
CRJ-100ER	CF34-3A1

Aircraft Model	Engine Options
CRJ-100LR	CF34-3A1
CRJ-200ER	CF34-3B1
CRJ-200LR	CF34-3B1
CRJ-700	CF34-8C5B1
CRJ-700ER	CF34-8C1
	CF34-8C5B1
CRJ-900ER	CF34-8C5
	CF34-8C5A1
CRJ-900LR	CF34-8C5
	CF34-8C5B1
DHC-6-100	PT6A-20
	PT6A-27
DHC-6-200	PT6A-20
	PT6A-27
	PT6A-27A
	PT6A-34
DHC-6-300	PT6A-27
	PT6A-34
DHC-6-400	PT6A-34
DHC-7-100	PT6A-50
DHC-8-100	PW120A
	PW121
	PW121A
DHC-8-200	PW123C
	PW123D
DHC-8-300	PW123
	PW123B
	PW123E
DHC-8-400	PW150A
DO-228-100	TPE331-5-252D
DO-228-200	TPE331-10-252D
	TPE331-10GP-511D
	TPE331-10GT
	TPE331-10GT-511D
	TPE331-10T-511D
	TPE331-5-252D
	TPE331-5A-252D
DO-328 Jet	PW306B
DO-328-100	PW119B
	PW119C
E-170	CF34-8E5A1G01
	CF34-8E5G01
E-170LR	CF34-8E5A1G01
	CF34-8E5G01
E-175	CF34-8E5
	CF34-8E5A1G01
	CF34-8E5G01
E-175LR	CF34-8E5G01
E-190	CF34-10E
	CF34-10E5A1G07
	CF34-10E5G07
	CF34-10E6G07
E-190AR	CF34-10E
	CF34-10E5A1G05
	CF34-10E5A1G07
	CF34-10E5G05
	CF34-10E5G07
	CF34-10E6A1G05
	CF34-10E6A1G07
	CF34-10E6G05
	CF34-10E6G07
	CF34-10E7B
	CF34-10E7G07
E-190E2	PW1919G
E-190LR	CF34-10E
	CF34-10E5A1G07
	CF34-10E5G05
	CF34-10E5G07
	CF34-10E6A1G05
	CF34-10E6A1G07
	CF34-10E6G07
	CF34-10E7G07
E-195	CF34-10E5A1G07
E-195AR	CF34-10E
	CF34-10E5A1G07
	CF34-10E6G07
	CF34-10E7G05
	CF34-10E7G07
E-195E2	PW1921G
E-195LR	CF34-10E
	CF34-10E5A1G07
	CF34-10E5G07
	CF34-10E7G07
EMB-110	PT6A-27
	PT6A-34
EMB-120ER	PW118
	PW118A
	PW118B
EMB-120FC	PW118
	PW118B
EMB-120RT	PW118
ERJ-135ER	AE 3007A1/3
	AE 3007A2
	AE 3007A3
ERJ-135LR	AE 3007A1/3
	AE 3007A1E
	AE 3007A3
ERJ-140LR	AE 3007A1/3
ERJ-145	AE 3007A2

Aircraft Model	Engine Options
ERJ-145ER	AE 3007A
	AE 3007A1
	AE 3007A1/1
	AE 3007A1P
ERJ-145LR	AE 3007A
	AE 3007A1
	AE 3007A1/1
	AE 3007A1/2
	AE 3007A1E
	AE 3007A1P
ERJ-145XR	AE 3007A1E
F100	TAY MK. 650-15
F50	PW125B
	PW127B
F70	TAY MK. 620-15
J31	TPE331-10UF-511
	TPE331-10UF-513
	TPE331-10UG-513
	TPE331-10UG-513H
	TPE331-10UG-514
	TPE331-10UG-514H
	TPE331-10UG-515H
	TPE331-10UGR-513
	TPE331-10UGR-513H
	TPE331-10UGR-516H
	TPE331-10UR-513
	TPE331-10UR-513H
	TPE331-10UR-516H
J32	TPE331-12UA-701
	TPE331-12UA-702H
	TPE331-12UA-703H
	TPE331-12UA-705
	TPE331-12UAR-701
	TPE331-12UAR-701H
	TPE331-12UAR-702H
	TPE331-12UAR-703H
	TPE331-12UAR-704
	TPE331-12UHR-701
	TPE331-12UHR-701H
	TPE331-12UHR-702H
	TPE331-12UHR-703H
J41	TPE331-14G-HR-802H
	TPE331-14G-HR-805H
	TPE331-14GR-802H
	TPE331-14GR-805H
	TPE331-14GR-807H
	TPE331-14HR-801H
	TPE331-14HR-802H
	TPE331-14HR-805H
	TPE331-14HR-807H
	TPE331-14HR-901H
MA700	PW150C
MC-21-200	PD-14A
	PW1431G-JM
MD-10-30F	CF6-50C2
MD-11F	CF6-80C2D1F
	PW4460
	PW4462
MD-81	JT8D-217C
MD-82	JT8D-217A
	JT8D-217C
	JT8D-219
MD-83	JT8D-217
	JT8D-219
MD-87	JT8D-217C
	JT8D-219
MD-88	JT8D-219
MERLIN/METRO	TPE331-10UA-511G
	TPE331-11U-611G
	TPE331-11U-612G
	TPE331-3U-303G
MERLINIVC	TPE331-11U-611G
	TPE331-11U-612G
	TPE331-11UA-601G
METRO23	TPE331-12U-701G
	TPE331-12UAR-701G
	TPE331-12UH-701G
	TPE331-12UHR-701G
METROII	TPE331-10U-501G
	TPE331-10U-511G
	TPE331-10UA-511G
	TPE331-10UA-512G
	TPE331-11U-611G
	TPE331-3UW-303G
METROIIIA	TPE331-11U-511G
	TPE331-11U-601G
	TPE331-11U-611G
	TPE331-11U-612G
METROIIIB	TPE331-12UHR-701G
MRJ90	PW1217G
S2000	AE 2100A
SH330	PT6A-45R
SH360-100	PT6A-65R
SH360-200	PT6A-65AR
SH360-300	PT6A-65AR
	PT6A-67R
SJ100-95B	SAM146-1S17
	SAM146-1S18
SJ100-95LR	SAM146-1S18

Source: Avitas, April 2022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