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Unprecedented times lead to adaptation

This year's guide to financing and investing engines could not have come at a worse time.

True the aircraft and engine finance and leasing markets had been very active over the past 12 months, although dark clouds were over the horizon.

Aggressive pricing in transactions over the past few years have benefitted from market conditions: low interest rates and abundance of liquidity in the marketplace.

But the Covid-19 crisis has changed all of this.

As one source said the market is virtually dead at the moment.

Another source points to the different crises that the aviation industry has weathered over the past 20 years, but stresses that the industry has never been at a standstill. "Who could have guessed an industry that has no flying passengers," he says.

"This crisis follows historic downturns, but for me it is 10 times the level of 9/11," says a US source, adding that every engine class in portfolios is being affected.

According to him, asset values are literally non-existent at this time and it will be months before the dust settles.

Prior to the Covid-19 crisis, the engine market was perceived as good and active. True, there were aggressive deals with low lease rate factors, which had a negative impact on the market, but airlines were defining their fleets for the summer season as they were planning how to cope without the Max models.

All discussions about adjusting capacity and flexibility are now gone. "Everyone has dropped every deal they had under letters of intent and are trying to understand the situation and the consequences," observes an engine trader.

"All the hubris and aggressive growth of the leasing companies will cause a lot of pain in the space. We already believed there to be a bubble, but nobody could have seen it being popped by this," he adds.

The market had a fair amount of spares and the increase in shop visit removals has driven up used serviceable materials consumption.

But shop visits will now pause as airlines, as part of their plan to protect cash, are now delaying non-essential maintenance projects.

Some aircraft will come back earlier than others and may require some spare engines, but airlines may also be tempted to preserve cash, by burning green time and swapping engines on their fleets. And in order to avoid shop visits they may turn to engine owners looking to exchange runout engines for serviceable engines from their lease pool.

The industry is in an unprecedented situation whereby airlines will have weaker post-summer season cash positions going into a further depressed winter season.

There will be bankruptcies and there should be concern about the impact a swathe of engines hitting the market will have on values on lease rates for the global fleet.

Beyond the liquidity and revenue crisis for the operators, the extra capacity aspect causes a significant challenge for aircraft and engine lessors.

As they work with airlines on short-term solutions, lessors have one thing in mind: avoiding early returns.

"The challenge for lessors is to work around the uncertainly of the sector," stresses one lessor.

"Flexibility is key among all players (banks, lessors and lessees). This is not a time about who is stronger but more about who is adapting," he adds.

Liquidity is certainly key at times like this but relationships are equally crucial.

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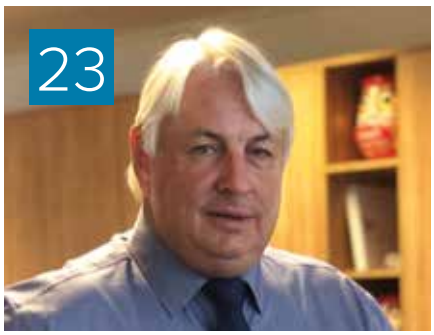

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CFM targets 10 737 Max engines weekly

CFM International is planning to produce an average of 10 LEAP-1B engines – the powerplant for the Boeing 737 Max – a week over the course of 2020, out of a total annual LEAP production of 1,400 engines.

The forecast was disclosed by CFM partner Safran in its full-year financial figures in late February, assuming that 737 Max deliveries restart mid-2020. Boeing halted production of the Max models in January but has indicated that deliveries of the narrowbody could recommence about mid-year.

CFM remains ready to increase output if required, said Safran's chief executive officer, Philippe Petitcolin in February. Any production increases would need to be agreed with the engine manufacturer's supply chain, which has been under pressure to meet future increases in the A320neo programme. Airbus had plans to increase its narrowbody production up to 63 aircraft a month in 2021, and potentially to 67 by 2023, prior to the Covid-19 crisis. The manufacturer indicated in early April that its new average A320 production rate is 40 aircraft a month.

Petitcolin says the 10-a-week rate is the minimum level required to maintain an "industrial" cost for the programme, rather than a "prototype kind of cost". But he cautions that some smaller suppliers are feeling "a little bit brittle" and may require additional assistance from Safran and CFM.

"They have some financial situations which are not so good for some of them and we are supporting them the best we can in order to avoid any big problems for them," he says.

Safran has implemented a hiring freeze, cost-saving efforts and a reduction in capital expenditure to help offset the impact of the Max situation.

The grounding of the Max fleet since March 2019 has impacted the engine joint-venture activity. LEAP orders and commitments reached 1,968 last year compared with 3,211 in 2018.

Safran says production levels over 2019 were nevertheless "stable". Although LEAP production rose to 1,736 engines, combined LEAP and CFM56 deliveries were down by 35 engines at 2,127 shipments, reflecting a 63% decline in CFM56 output to 391 as well as the Max lines. The LEAP backlog at the end of 2019 stood at 15,614, unchanged from the previous 15,620-engine backlog at the end of 2018.

The manufacturer says 55 airlines are operating 632 aircraft powered by LEAP-1A engines at the end of last year. Before the grounding of the 737 Max, 54 airlines were operating 387 aircraft powered by LEAP-1B engines.

Despite the Max grounding's effect on LEAP-1B deliveries, Safran's original equipment revenues for aerospace propulsion rose by 13.5% while service revenues were up 14.2%.

Higher spares sales for CFM56 engines contributed to a 9.9% hike in civil aftermarket revenues.

Recurring operating income was up by more than 22% to €2.48 billion ($2.7 billion), with profitability benefiting from civil aftermarket growth and higher military contributions.

Safran's outlook anticipated civil aftermarket growth in the high single digits, so long as disruption created by the coronavirus on air traffic does not extend beyond the first quarter of 2020. The manufacturer did not provide any update at press time.

First Japan-built PW1200G completes maiden flight

The first Japanese-made Pratt & Whitney PW1200G geared turbofan completed its maiden flight in the first quarter of 2020.

Mitsubishi Heavy Industry's (MHI) engines unit manufactured the powerplant, which was shipped last November from its Komaki facility in Japan to sister company Mitsubishi Aircraft's flight test centre in Moses Lake.

The airframer says the first flight with the Japan-made powerplant was performed by the company's Flight Test Aircraft 1 on 14 February. The engine joined the rest of the flight test fleet.

Mitsubishi Aircraft's president, Hisakazu Mizutani, says: "This is the first flight with an engine completed in Japan, and represents an important milestone for Mitsubishi Aircraft, our SpaceJet family of aircraft and the further development of the aerospace cluster in Japan."

MHI Aero Engines signed an agreement with Pratt & Whitney in 2008 for the production and testing of the PW1200G engine.

The assembly of the first PW1200G, which will power Mitsubishi Aircraft's SpaceJet regional jet aircraft, began in 2017 in Japan.

After test cell approval, completion of the first full engine assembly and subsequent testing, analysis and verification, the second engine assembly and testing was completed last year. The first engine was shipped to MHI Aero Engines in the final quarter of 2019.

The PW1200G production line at MHI Aero Engines' Komaki facility will commence production on obtaining a production certificate from the US Federal Aviation Administration.

Mitsubishi Aircraft completed the maiden flight of Flight Test Vehicle 10 (FTV10), the first Mitsubishi SpaceJet M90 in final, certifiable baseline configuration in March.

The manufacturer plans to continue flight tests in Nagoya, as well as prepare for the ferry flight to Moses Lake flight test center to join the remainder of the SpaceJet M90 test fleet for the final phase of type certification flight test.

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CFM strikes payment deal with Boeing

Engine joint venture CFM International struck an agreement in February to receive payment from Boeing for all LEAP-1B powerplants delivered this year.

Although detail of the pact remains "confidential", Safran chief executive officer, Philippe Petitcolin, told analysts in a 27 February full-year results call, it covers all LEAP-1B production this year.

"All engines which are going to be produced in 2020 will be fully covered," he says.

The deal, covering the net cost, also includes provision for powerplants built last year, he says, with payments running until 2021 when they "will be complete".

Safran, which is a partner in the CFM international joint venture with GE Aviation, says free cash flow in 2019 was impacted as a result of the Boeing 737 Max grounding. The company estimates a €700 million ($777 million) impact, in line with previous announcements.

HAECO buys Jet Engine Solutions

Hong Kong Aircraft Engineering Company (HAECO Group) announced in late March the acquisition of aero-engine maintenance provider Jet Engine Solutions (JES).

Christopher Gibbs

The Dallas-based company specialises in quick-turn repairs and lease returns for commercial aircraft engines. Founded in 2009, it operates 14 engine bays from its 12,000 m2 premises located in Carrollton, Texas, and is capable of storing up to 120 engines. The facilities are supported by employees with deep industry experience in providing maintenance services to a wide range of blue-chip customers on most in-demand engines, such as the CFM56 and LEAP families.

The acquisition forms part of HAECO's strategy to grow its global engine support business.

It marks HAECO Group's debut in North America's on- and near-wing aero-engine market, forming part of HAECO's strategy to grow its global engine support business and enabling the company to strengthen further its quality services to customers worldwide. It is also opening a new global engine support facility near Amsterdam airport. Christopher Gibbs, HAECO Group director, components and engine services, says: "JES has a strong reputation within the engine maintenance business for quality and delivery in the United States, which will complement the HAECO Global Engine Support business."

HAECO has had a new chief executive officer since last December. Frank Walschot joined from SR Technics where he was also CEO.

"JES represents a significant strategic development for HAECO Group. We see very strong market demand for customer-focused, timely on- and near-wing aero-engine support with global reach. Through this acquisition, we will build on this capability at the heart of one of our most important markets," he says.

Walschot adds that the development of the HAECO global engine support network offers hospital and in-field maintenance as part of the HAECO engine services strategy.

"Together with HAESL and TEXL, our Rolls-Royce and GE overhaul businesses, HAECO Group will provide a full range of services from on-wing repairs to full performance restoration, for a wide range of the most modern engines being operated on commercial aircraft," says Walschot.

Seabury Capital Group, via its London and New York-based aerospace and defence investment banking teams, assisted Hong Kong Aircraft Engineering Company in the acquisition of JES.

WLFC records $20m asset sale gains

Willis Lease Finance (WLFC) recorded a $20 million gain on the sale of leased equipment in 2019, reflecting the sale of 16 engines, seven aircraft, four airframes and other related equipment from its lease portfolio.

This compared with a $6.9 million gain in 2018, when it sold 14 engines, six aircraft, one airframe and other related equipment.

The engine lessor reported $409 million annual total revenues (a 17.5% increase over 2018) and pre-tax profit of $88.9 million for the year ended 31 December 2019.

WLFC says its pre-tax results were driven by continued leasing revenue growth as well as gains associated with the active management of its portfolio.

Lease rent revenues totalled $191 million in 2019, an increase of 8.6% on the $176 million in 2018. Maintenance reserve revenues reached $109 million, an increase of 25.3% compared with $87 million the previous year.

Long-term maintenance reserve revenues increased to $37.6 million in 2019, from $23.3 million in 2018.

"There is obvious volatility in the global markets, generally, but we believe the company is well positioned to continue to build market share and grow customer relationships by leveraging our in-demand portfolio of lease assets and continuing to focus on delivering unique customer solutions," says Charles Willis, chairman and chief executive officer.

WLFC maintained $603 million of undrawn revolver capacity at 31 December 2019.

On the same date, the company had a total lease portfolio consisting of 263 engines, 12 aircraft, 10 other leased parts and equipment and one marine vessel with a net book value of $1.65 billion. It owned four Boeing 737 aircraft, eight A319s with an aggregate net book value of $138.9 million.

In addition, WLFC managed a total lease portfolio of 450 engines, aircraft and related equipment for other parties.

Rolls-Royce prepares for 'prolonged' trading dip

Rolls-Royce drew its £2.5 billion ($3.1 billion) revolving credit facility in April and arranged an additional revolver totalling £1.5 billion with a consortium of banks.

The British manufacturer now has gross cash of £5.2 billion, expandable to £6.7 billion with the new revolving credit facility, which it believes will ensure sufficient cash headroom to handle "a prolonged reduction in trading activity".

Rolls-Royce has one outstanding debt maturity in 2020, a $500 million bond due for repayment in the second half of the year. None of its borrowing facilities contain any financial covenants nor are they dependent on its public credit rating.

The company plans to reduce cash expenditure by £750 million in 2020 through measures including salary cuts, lower discretionary costs and a recruitment freeze.

The Rolls-Royce board also wants to withdraw the company's previously planned dividend for 2019, which would have amounted to £137 million.

Because of the limited visibility of the duration and impact of the Covid-19 pandemic, Rolls-Royce has also withdrawn its financial guidance for 2020.

"Our airframe and airline customers are facing unprecedented business challenges and we are in close communication with our customers and suppliers as we prepare for an anticipated reduction in engine delivery and MRO [maintenance, repair and overhaul] volumes," the company stated on 6 April.

"We are now in a position where eight out of nine design changes are done."

Warren East, chief executive officer, Rolls-Royce

Rolls-Royce says the primary impact from Covid-19 has been on engine flying hours in its civil aerospace business.

Widebody flying hours fell by about 25% in the first quarter, compared with the previous year, and fell about 50% in March, with an expected further deterioration in April and beyond as airlines have grounded an increasing proportion of their fleets over the past few weeks.

Output of new widebody engines remained broadly stable in the first quarter as airframe customers maintained production levels. However, its airframe and airline customers are facing unprecedented business challenges and the company is preparing for an anticipated reduction in engine delivery and MRO volumes.

Rolls-Royce reported significant progress on fixes to the troubled Trent 1000 turbofan and its actions to reduce the number of aircraft on the ground (AOG) continued to deliver positive results.

"During the year we've made pretty good progress – good progress in actively managing the situation, continuing to extend our MRO capability and capacity," said Rolls-Royce's chief executive officer, Warren East, in February. "We are now in a position where eight out of nine design changes are done."

The manufacturer expects certification of a redesign of part of the Trent 1000 Package B intermediate-pressure compressor sometime during the second half of the year.

At the end of March, the AOG status was in the mid-20s, down from the mid-30s reported at the end of February.

The manufacturer says sufficient overhauled engines are now delivered to achieve below 20 when all fitted to aircraft.

"We expect to reduce this to single-digits by the end of the second quarter and, to date, our MRO facilities are still operating, despite Covid-19 disruptions," it says, adding that design work remains on schedule to resolve the last remaining technical issue, a new high-pressure turbine blade for the Trent 1000 TEN engine, with ground testing of the new blade progressing through the second quarter.

The manufacturer adds: "We continue to expect the new design to be ready for incorporation into the fleet by the end of first half 2021."

No engine spared in current environment

It has become increasingly clear that the market impact of Covid-19 is unlike any recession or any market shock we have ever seen. As a result it is difficult to predict any criteria such as remarketing demand, residual values and appetite for engines.

As one engine source points out, the market is in stasis essentially for the next three to six months.

"The coming out of the airlines from this particular crisis will likely be that capacity will be 25-30% less than when we went into it. Therefore the residual value of engines are only reinforced by an ability to operate them," the source tells *Airfinance Journal*.

It is indeed difficult to gauge the impact on current market values and lease rates across all engine types but in the short-term, the impact on demand is closely linked to general fleet trends.

Engine lessors have grown their fleets significantly over the last decade through sale and leasebacks of new and used engines, giving operators the enticement to free up cash. Lease rate factors have become increasingly lean as competition for sale and leaseback opportunities has developed.

"Sub-0.6% lease rate factors are not uncommon these days and have been part-facilitated by prevailing low financing costs observed within the aircraft and engine finance sector. The ongoing Covid-19 situation and its sudden impact on the aviation industry has clearly created some uncertainty whether financing costs will stay as low going forward," says an engine trader representative.

One engine lessor agrees. "There will be a resetting of the leasing provisions as the low finance rate has encouraged the operators to benefit from advantageous terms, which are now not likely to be considered."

The engine market has been a seller market for a while but many argues there is literally no market at present.

"Every market has dropped and there is oversupply in every asset class. This will accentuate the flood of engines spares," says one source. The MRO shops, which were full at the beginning of the year will be affected as airlines, in order to preserve cash, are not likely to perform engine shop visits.

The widebody fleets will not be as active as the narrrowbody fleet, says one participant in the engine poll.

Even so, demand for leased engines on the narrowbody side will be highly depend on airlines' fleet structures and how operators balance them.

"Which aircraft will be prioritised?" asks one engine lessor's representative.

"Airlines will try to preserve cash and optimise capacity as much as they can. I can see them using engines from grounded aircraft when resuming operations and beyond," he adds.

Another engine source says current low fuel prices removes one barrier to market recovery. "If one looks at the 2008 global financial crisis, that period also coincided with high fuel prices, which exacerbated the pressure on airlines. Low fuel prices and a possible surfeit of used aircraft, can only have a positive impact on short to mid-term demand for engines. As was the case during past downturns, engine fleets with the widest, most diverse network of operators will be best placed in terms of demand when the market recovers."

Narrowbodies

The narrowbody fleets should come back first, but one participant anticipates up to 12 months for demand to peak again. In that scenario, the parts market will recover last, as airlines will use spares in lieu of repairs.

For him the CFM56-5B, CFM56-7B and the V2500-A5 engine variants are prime candidates to recover in the leasing space. However, he cautions that because the overcapacity situation, already before the Covid-19, normalisation in those markets will not happen before one year.

One engine lessor agrees those engine models will recover first.

Demand for the -5B engine was healthy prior to March, says the lessor, who admits that the market was starting to get soft towards the end of last year. "We could see some softening in the market as some engines were coming off lease and operators were using green times from other engines," he says.

The V2500-A5 engine falls into the same category and its recovery depends on the airlines' fleet composition post-Covid-19.

For the lessor representative, the -7B engine has the greatest chance of recovery because of the uncertainty of the Max programme. "Airlines were trying to find capacity for the summer period to fill the gap," he says.

"One can expect further A320neo/737 Max order cancellations in the coming weeks and months, which could have a positive impact on CFM56-5B/7B and V2500-A5 lease demand," says another participant.

On trading source points out the solid demand for the -7B models, which benefits from thrust divergence.

Narrowbodies aircraft

	Investor appeal (out of 7)	Remarketing potential (out of 7)	Residual value (out of 7)
BR715 (717)	1.11	1.30	1.44
CFM56-3C (737 Classic)	2.30	2.91	2.60
CFM56-5A (A320 family)	2.20	2.45	2.50
CFM56-5B (A320 family)	5.40	5.18	5.60
CFM56-7B (737NG)	5.50	5.00	5.30
CFM Leap-1A (A320neo family)	6.38	5.67	6.38
CFM Leap-1B (737 Max family)	5.13	4.22	5.13
IAE V2500-A1 (A320 family)	2.00	2.00	1.80
IAE V2500-A5 (A320 family)	5.00	4.82	5.00
PW2000 (757s)	3.00	3.45	3.00
PW6000 (A318)	0.89	0.90	1.11
PW1100G (A320neo family)	6.00	5.33	5.88
PW1500G (A220 family)	5.75	4.78	5.50
RB211-535 (757s)	2.89	3.40	3.11

Source: Airfinance Journal, April 2020

"The healthy aftermarket will keep investors busy with this engine. We do see more V2500s exiting service compared to the CFM56-5B."

The V2500-A5 and CFM56-5B scorings have gone down in the past 12 months in terms of investor appeal, remarketing potential and residual value.

"The healthy aftermarket will keep investors busy with this engine. We do see more V2500s exiting service compared to the CFM56-5B," says a participant.

The LEAP-1A was the best engine for investor appeal, remarketing potential and for residual values, in this year's engine poll.

It scored 6.38 out of seven for investor appeal, 5.67 for remarketing potential and 6.38 for residual values.

As predicted the LEAP-1B engine had a turn of fortunes. In the previous engine poll, which was done before the grounding of the Max fleet, the engine scored the highest for investor appeal, third in remarketing potential and second for residual values.

In this year's poll, the LEAP-1B remarketing potential was, understandably, impacted.

The PW1100G, which came second in the poll, scored slightly less than in 2019 but the perception is more positive, especially as Pratt & Whitney continue to solve the engine's technical problems.

"We think the GTF is turning a corner. It seems to have got over delivery hurdles and is keeping up with intended rates. We expect Pratt & Whitney to start focussing on other GTF engines for other platforms. This is where I would put my money now," says one participant.

At the other end of the market, the main question is the future demand for mature engines.

The Boeing 737 Classic aircraft are prime example as over the years, the CFM56-3C engine market was very active as airlines and lessors retired older aircraft to make way for new models. The green time on mature engines is also perceived as having improved over the years.

"Whilst there are operators, there will still be support, and we still this in North America and Europe. There is still a market for used materials and used life limited parts and commonality does exist on later CFM56 programmes albeit on lower ticket components," says one participant.

Another participant in the poll expects a "niche demand" in the near term.

Widebodies

One engine trading source predicts the cargo market will be a lifeline and saviour for the industry. "The cargo market is only a fraction of the overall market but some engines like the CF6 and PW4000 will perform ok, despite the excess capacity."

The 767 freighter fleet drives the CF6-80C market as airlines are more retiring 747s. It is a strong aftermarket presently. Although on the passenger side, American Airlines is retiring some 767-300ERs, cargo demand is still good with Amazon adding more units. The CF6-80C market benefits from solid lease and parts demand.

The market for the four-engine aircraft is heavily impacted and with the news of many 747s potentially not coming back along with A340s, A380s, it is difficult how trading could benefit.

The CFM56-5C still ranks above the likes of the Trent 553/556 engines, or Rolls-Royce Trent 800/900s and the JT9D models.

The PW4000 continues its solid performance. The engine ranked as second best in terms of remarketing potential highlighting diverse market applications: freighter-passenger-military.

"The PW4000 engines power different markets but with commonality particularly in the core. Values have been fairly static. The PW4000-94 benefits by being part of the KC-46A USAF tanker programme."

One trading source observes that Pratt & Whitney are not overhauling many engines and therefore operators of the type are keen to buy.

The GEnX engines remain the best performer in the widebody category in terms of investor appeal, remarketing potential and residual value.

Widebodies aircraft

	Investor appeal (out of 7)	Remarketing potential (out of 7)	Residual value (out of 7)
CFM56-5C (A340s)	1.73	2.08	2.00
CF6-80C2 (747s, 767s)	3.20	3.55	3.10
GE90 (777s)	3.33	3.40	3.44
GEnX (787s, 747-8s)	5.75	4.44	5.38
GP7200 (A380)	1.22	1.50	0.02
JT9D (747s, 767s)	1.20	1.45	1.50
PW4000 (A330s, 747s, 767s, 777s)	3.18	4.08	3.18
RB211-524 (767s, 747s)	1.40	1.64	1.70
Trent 553 (A340-500)	1.00	1.09	0.90
Trent 556 (A340-600)	1.00	1.09	0.90
Trent 700 (A330s)	2.60	2.80	2.60
Trent 800 (777s)	1.30	1.45	1.30
Trent 900 (A380)	1.10	1.36	1.30
Trent 1000 (787s)	3.22	3.30	3.22
Trent 7000 (A330neo)	3.38	2.89	3.38
Trent XWB (A350s)	4.22	3.50	4.22

Source: Airfinance Journal, April 2020

"The PW4000 engines power different markets but with commonality particularly in the core. Values have been fairly static. The PW4000-94 benefits by being part of the KC-46A USAF tanker programme."

Most operators will be in a programme but new operators of the type will need engines. Most sources agree the GEnX-1B is one of the best asset to have in the widebody market segment.

GEnX-1B is one of the best asset to have in the widebody market

The GEnx-2B is not to be considered in the same bracket although it has somewhat of a freight presence, which should help.

The Trent 700 benefits as a fleet leader, which will generate demand, according a trading source. Rolls-Royce have been outsourcing maintenance work and this is expected to continue.

Secondary market needs yet to develop for the Trent XWB models despite the popularity of the Airbus A350-900/1000 models. Still The XWB ranks second best in this year's engine poll. Of concern is the impact on the GE90-115B models.

One trader points out that later-build models are expensive to maintain and "the market has woken up to this." Appraisers have had to adjust GE90-115 values downwards, and not just a few percentage, he adds.

The widebody market has been in a difficult remarketing environment for a while and the 777-300ER market along with the market for A330s are a tough re-marketing proposition because of their size.

"We should start to see more transition of 777-300ERs from their original operators to secondary markets," says a source, adding that it should create more engine demand.

Regionals

Regional aircraft could benefit from a quick recovery from the Covid-19 crisis, according to an engine lessor.

The governments are keeping some essential services routes performed by regional carriers. But there is an assumption that regional aircraft will provide more flexibility to airlines when resuming operations.

"Airlines will be looking at capacity adjustments through aircraft in operations, slots and frequencies and in a low factor environment, regional aircraft could substitute some narrowbody aircraft," says the lessor.

The Pratt & Whitney PW1919 engine, a relatively new entrant in the poll, is the best performing in-production regional aircraft in the investor's appeal and residual value.

Regional aircraft

	Investor appeal (out of 7)	Remarketing potential (out of 7)	Residual value (out of 7)
CF34-8C (CRJs)	3.22	3.30	3.33
CF34-8E (E170/175)	3.67	3.60	3.33
CF34-10E (E190/195)	3.22	3.20	3.22
PW123 (Dash 8)	2.43	3.00	3.17
PW127E (ATR42-500)	2.63	2.89	3.13
PW127F (ATR72-500)	2.75	3.11	3.38
PW127M (ATR72-600)	3.38	3.22	3.63
PW150A (Q400)	2.63	2.44	2.75
PW1919 (E190/195-E2)	3.86	3.00	3.71

Source: Airfinance Journal, April 2020

The PW1919 engine, is the best performing in-production regional aircraft in the investor's appeal and residual value

The geared turbofan engine family, currently selected as the exclusive engine for the Airbus A220, Embraer's second generation E-Jets and Mitsubishi SpaceJet, is growing in popularity along with market acceptance.

The PW1919 was ahead of the PW127M model, which has benefitted from the popularity and trading activity of the ATR72-600 since 2011. The PW127M remains a solid performer in terms of value retention. "Major players include Willis and Lufthansa Technik, which speaks volumes to me." Says a trading source.

The CF34-8E engine came first in remarketing potential, reflecting the level of activity of the Embraer 170/175 fleets in the marketplace. Demand for the type has been high as well as for the CF34-8C engine model early into the year.

The CF34-10E has enjoyed even more trading than the -8E market and it is set to continue with some fleets additions at LOT Polish Airlines or start-up Breeze. Beautech Power Systems has had a firm grip on this market over the past two years, having acquired 25 aircraft from Air Canada.

Unprecedented times

In 2019, as it entered its 30th year in business, Tom Barrett, Engine Lease Finance Corporation's president and chief executive officer, suggested the independent engine lessor would still be around in a further 30 years. Now he wonders what sort of engine leasing company might be around in just a few years' time.

Everyone starting in aviation is told that it is a "cyclical" business. Last year at this time, with the unprecedented long run of profits and general good news for aviation, it was hard to see what event or series of events could bring the good cycle off its historic highs. Some speculated that it was past the peak but the level of new investment and terms that were available to airlines and aviation companies in general suggested otherwise. One year on, everything has changed.

Cycles come and go in this business and in 30 years Engine Lease Finance Corporation (ELF) has experienced about 10 different regional and global events and a few cycles that have had a dramatic effect on the business.

The firm has been exposed to cyclical downturns early on.

It acquired its first two engines with leases attached to Continental Airlines in March 1990, a few months before the downturn that followed the first Gulf War, which started in August 1990.

By December 1990, Continental Airlines had filed Chapter 11 and the ELF team was scrambling to source lawyers who could advise what were the implications for its engines with the US airline. While ELF was tiny by comparison, some of the consequences of the events that followed would lead to the decline of the then aircraft lessor market leader, Guinness Peat Aviation, which was ultimately forced to pull its initial public offering in June 1992.

Other events were to follow, including the 1997 Asian financial crisis, which prompted very different arrangements and issues for ELF with its most recent Asian customer, which then accounted for 50% of its portfolio, dramatically affected.

This crisis was followed by 9/11, a second Gulf War, a SARS epidemic and, in 2008, a worldwide financial crisis that led to a prolonged global recession and had a significant impact on the business of aviation.

The Covid-19 crisis of 2020 has, at least in ELF's experience, touched the world of aviation in a far more profound and truly global way than anything that went before. The level of groundings, shutdowns, cancellations, manufacturing cessations and cash shortfalls throughout the industry is new territory.

> *"The Covid-19 crisis of 2020 has, at least in ELF's experience, touched the world of aviation in a far more profound and truly global way than anything that went before."*
>
> **Tom Barrett**, president and chief executive officer, Engine Lease Finance Corporation

Despite the current evidence of some green shoots as People's Republic of China domestic flights gradually resume (hopefully many more will have done so by the time of publication), there really is no certainty anywhere when flights will get back to the level that might be considered normal. In addition, the debates, involving many much more learned people than this author, are starting as to what will be the future shape of this business.

As a company in this cyclical business for 30 years, I have to say we have not seen anything like this before.

Immediate issues in midst of a crisis

The implications of this crisis continue to play out. There will be many papers and books that will dissect all that has happened and what will come to pass but the truth today is that nobody knows the final outcome.

However, what we can say right now is that many of the immediate impacts, although global in nature this time, have been seen in the various regional or other crises in the past. It is clear that the public is not flying, aircraft are grounded, airlines' cash reserves are dwindling fast, the herd mentality of the financial markets is making it more difficult to access liquidity and there is consequent pain for everyone involved in the industry.

In terms of the key areas for any lessor, namely new acquisitions, utilisation of the portfolio, lease rentals and residual value retention, all have been directly and immediately impacted in common with every previous crisis.

The questions arise now about how each of these will play out over the near term and ultimately longer term as normal conditions return (if we are to see them again). Or post-Covid-19, are we to see a new normal?

New acquisitions

Clearly and long before this crisis, the debate has raged about the level of original equipment manufacturer (OEM) aircraft production. There were many (usually those who had to market an order they themselves had placed) who suggested that the production rates were too high and unsustainable. There were others (the OEM and those that wanted to make an order) who suggested the production levels were appropriate.

As of the second quarter of 2020, that discussion is over because it is clear the production rates envisaged a couple of years ago would be, were they continuing, far too high for the demand that will follow in the remainder of 2020, 2021 and maybe longer.

With airlines' cash flows under pressure for the remainder of 2020 and into 2021, and the stark reality being that route plans will have to change, it is inevitable that airlines and lessors will seek to postpone or cancel orders or defer plans for new aircraft. This is expected to continue until airlines begin to see the demand returning to pre-crisis levels. In the meantime, more will be asked of the current fleets, which at today's fuel prices will provide competitive economics, to see the airlines through before refleeting resumes.

The sale and leaseback market, where ELF has traditionally sourced the majority of its products, has seen irrational low pricing with full values being paid. It is my view that there will, regardless of the funding increases imposed by the financiers in the short term, be a return to more rational pricing of sale and leaseback lease rentals. This will more appropriately reflect the risks in this business.

The pricing of the equipment too will see much more scrutiny in the period ahead and it will be interesting to see what trading and pricing of aircraft and engines will take place in the second half of 2020. Whatever it is, it will be less than before and business models that are totally dependent on

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trading, rather than asset management, will need to come up with new or innovative ways to operate.

Utilisation will drop

This is likely to be one of the least predictable areas for the lessors. Nobody knows when aircraft will be in operation again, or what aircraft will return to service versus being parked longer term. For those re-entering service, will the emphasis be on newer technologies or will the Boeing 737NG/Airbus A320 core aircraft of the past 20 years, with fuel prices as low as they are now, be more desirable, as airlines try to avoid large capital outlays until they have a chance to rebuild their balance sheets and gain access to acceptable finance for such investments?

It would appear that the shorter haul, and larger domestic markets, will rebound first and this should augur well for the lessors which are more active in the existing narrowbody markets.

It will be more problematic for the return to normal service in the international, and in particular long-haul, traffic as various countries, and their citizens, may be less open and accessible as has been the case prior to the current crisis. It is likely, as the virus revisits countries that were previously seeing reductions in infections, that it will lead to some form of restrictions on international and global travel.

Spare engines will be in oversupply

Before the Covid-19 crisis, I had been wondering about the optimistic shop visit forecasts that were becoming the perceived wisdom for the industry. It was obvious that they built in little downside risk and assumed the growth profile seen in recent years continued. Whether they were optimistic or not, the fact is that with so many aircraft parked, and no matter how long it continues, it is inevitable that the previous forecasts are in need of revision.

With the decrease in shop visits and any continuing storage of aircraft (and each having two "spare" engines on wing), the demand for spare engines can only decrease. The result being oversupply and average periods in inventory for engine lessors to extend.

An accompanying graphic shows how the months in inventory for one of its three core narrowbody engines behaved in ELF's portfolio between 2012 and 2019, after the global financial crisis.

Average months in inventory

The number of average months in inventory reached a peak of more than a year in February 2015, up from just over five months in February 2012. It was not until February 2017 that ELF's period in inventory of the subject engine type got back to the five months average seen in 2012.

Engine lease rentals will decline

It remains simple economics that a period of oversupply of spare engines for the current fleets will lead to downward pressure on lease rentals. An immediate consequence of the Covid-19 crisis will be that airlines will seek to avoid long-term cash commitments and instead rely on the spot lease market where there will be an abundance of engines available.

The spare engine lease market switched from a seller's (ie, lessors) to a buyer's (ie, lessee) market almost overnight earlier this year.

The consequences will hit lease rentals immediately and it may take years before the lease rentals, assuming the market switches to a period of undersupply, starts consistently to be above the rates that will be seen for the rest of 2020. In the near future, there will be a period of real volatility for engine rental rates.

The accompanying chart sets out how the lease rental rates for the core narrowbody IAE V2500-A5, CFM56-7B and CFM56-5B engines behaved in the ELF portfolio between a nominal base date in 2010 (two years after the global financial crisis started) and 2019. The volatility for one of the engine types was as wide as 60% between its lowest and highest rentals. Overall, there was volatility of between 20% and 60% across the three engines.

Although spare engines have not traditionally (with the exception of a few GE Engine Leasing vehicles and Willis Lease Finance's West vehicle) been a big part of the securitised or asset-backed securities (ABS) market, it will be interesting to see how these older vehicles and the two recent ABS structures, closed in early 2020, perform during the crisis. There may be things to learn for us all as we evaluate possible funding structures in the years to come.

Asset values will fall

Like all asset owners, the immediate result of a crisis, and the confidence it sucks out of the economy, is that buyers stop or slow all of their decision making. Within days of the closing of normal transatlantic travel, buyers stopped enquiring and mandates, which previously seemed certain, suddenly were uncertain.

As with past cycles, the buyers who will be active in the immediate aftermath of such a massive event as we are seeing will be the few lucky buyers with cash and all of them will be bottom fishers. The prices that will be offered for the next few months will not represent the full value of the engines but at least these buyers will provide a service by proving the liquidity of the asset, albeit at very opportunistic prices.

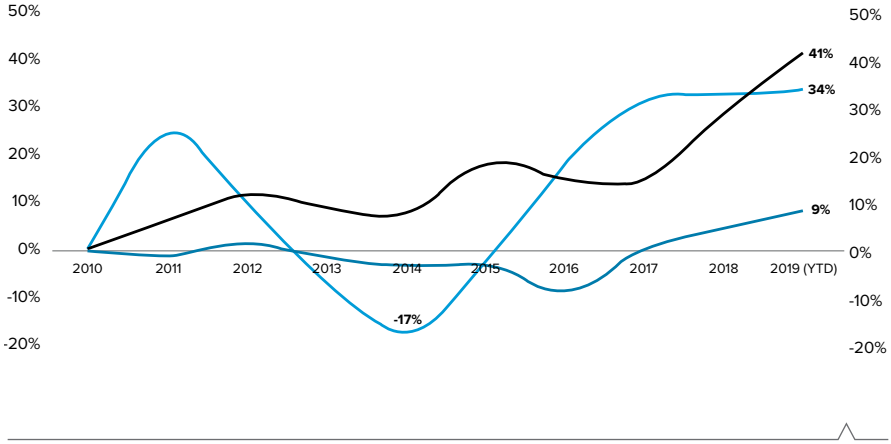
What will be very interesting to see over the next couple of years will be how current technology, the V2500-A5, CFM56-7B and CFM56-5B engine values, behave compared with the newer technology LEAP-1A and geared turbofan. Obviously, the LEAP-1B will only follow the return of the Max to service.

It would be my expectation that there will be tremendous volatility around the V2500-A5, CFM56-7B and CFM56-5B engine values, and clear consistent pricing will only develop when the level of retirement for the host aircraft in storage becomes clear.

It will be some time before full values return and for anyone who paid above the odds in the cycle just ended, or was under depreciating, or maybe taking all of their considerable maintenance reserve revenues to profit, there will be pressure. The issue for these lessors will be that poor discipline around these core areas will result in significant impairments and inevitably there will be eloquent explanations for any losses that follow. The excuses will flow, the use of words such

Average months in inventory

Lease rental rates for narrowbody IAE V2500-A5, CFM56-7B and CFM56-5B engines in ELF portfolio



as "once in a 100 years", "one-off", "never to be repeated", etc, will flow off the lips of countless lessors' senior managers, but the reality will be that if they adopted poor pricing strategies, or were reluctant to write down the assets properly, then the result is that in the inevitable cyclical downturn, they will be left suffering the consequences for their earlier poor decision making.

The pressure on asset values will be most obvious as the companies approach their audits where appraisal questions and impairment considerations will be inevitable. The good news is that, for most, the 2020 audits/results are still almost nine months away.

The overwhelming lesson for all lessors in this period is that it is sound pricing strategies that will separate the winners from those who played "musical chairs" and are left without a seat when the music stopped – ie, with the overpriced asset that nobody (airline or another investor) wants.

What will it take to be around in 2025?

While the emphasis of my article for this publication last year was on whether the industry needed an independent engine lessor by 2049, I realise in these times of crisis that nobody is (even if they ever did) thinking about 2049. Instead, everyone is thinking about 2020 and, at a stretch, a few (the lucky few) are thinking about their strategies to see them succeed over, say, a five-year horizon, into 2025.

The good news is that if a lessor maintained discipline around pricing strategies and depreciation/maintenance reserves write-offs, then it can be assured, once it has desirable assets, that it can have a future.

At this point, I would like to outline how ELF, as a 30-year veteran company, will react to its customers in this market and thus ensure it succeeds until 2025, and who knows maybe 2049. First, ELF will continue to follow very simple principles which include our focus to:

- understand our customers' needs and motivations for a deal;
- know what ELF can and cannot do to meet customers' wishes;
- keep open communication with customers so they are very clear on what ELF can offer; and
- honour our commitments (I am very proud that ELF was in a position during this crisis to honour mandates won prior to the onset of the crisis).

Second, ELF will be as flexible as is possible with all its customers. This is not a time to grandstand or punish customers with overly punitive opportunistic demands in return for some concession that might help that customer survive this crisis.

Third, as a portfolio manager, who has prudently depreciated and written down its portfolio in the good times, ELF will adapt its portfolio, its protocols and its plans to ensure that it is well positioned to match the new industry reality, whenever that emerges.

With the above customer-focused emphasis and by continuously using the experience for the past downturns, ELF is confident that it can, as a strong independent lessor, meet its customers' needs as they navigate this crisis.

Independents will remain crucial

Before closing, and not to lose sight of the industry trend that has dominated engine leasing for years, I want to comment on the OEM dominance in the engine leasing market. As is well known, and documented previously, all the major engine manufacturers have in-house engine lessors – ie, Rolls-Royce Partners Finance, Shannon Engine Support, GE Engine Leasing and Pratt & Whitney Engine Leasing.

As the orders rolled in on the LEAP and GTF engines in particular, there was considerable debate about aftermarket control. At times the Rolls-Royce model of control through programmes, repairs and MRO, and dominance in the leasing of its own products, must have seemed attractive to CFM International, General Electric and Pratt & Whitney.

As we navigate through these uncertain times, and entry into service issues remain for many of the engine programmes, I am firmly of the view that the OEMs will continue to "allow" the independents to operate in their market. The independent participants will be crucial to the OEMs because they will want to evidence liquidity of their product as they grow their markets once the entry into service issues are resolved.

As a fiercely independent lessor, which values the OEMs as lessees and partners from time to time, it will remain crucial for airlines that they have strong independents to provide:

- competitive pricing on lease rentals;
- flexibility to allow the airline use whatever maintenance (MRO) provider it chooses;
- through their parts subsidiaries, INAV in the case of ELF, quality used serviceable material; and
- a strong alternative to the OEM-only service outcome – ie, OEM make it, lease it, repair it and charge for it all.

In this independent path that ELF pursues, it has the considerable support of its parent, Mitsubishi UFJ Lease & Finance, which has been its owner since 2014.

It remains ELF's firm view that OEMs are better served focusing on manufacturing the engines, delivering the engines to airlines and, ultimately, in a level playing field, delivering the new spare parts.

Keep it simple

Can I apologise to anyone who sees little news in this article and say to the readers that while the extent of this crisis might be unprecedented, it remains a simple business. Those companies which will succeed are the ones which adopt the right asset pricing strategies, excel at customer focus, develop and retain the best staff and deliver stable returns consistently for their shareholder.

As every novice to the industry knows, there will be cycles and casualties in this business, but companies can survive if they keep it simple, remain focused on their customer and the asset.

What is their **role today**?

Manufacturers' long-term service agreements have forced third-party maintenance, repair and overhaul companies to look elsewhere, writes Kane Antony Ray, senior consultant at Counterpoint Market Intelligence.

With the advent of new single-aisle engine types, original equipment manufacturers (OEMs) have proposed customers to secure an increased amount of pre-sale long-term service agreements (LTSA) akin to those offered for their more historical twin-aisle engines.

These cost-per-flight-hour and cycle services can include extras such as on-site support, engine lease support, component repairs and even aircraft transitioning services for lessors; or an amalgam of services that can be tailored to specific customer requirements.

To date, Pratt & Whitney and CFM International have undoubtedly achieved what they set out to do with LTSA shares increasing on new-build engines. The strategy is a good one because they plan to recoup early programme losses originating from research and development and discounted airline engine sales. For airlines and other end users, OEM engine maintenance offers price guarantees, priority access to services and tailored maintenance throughout the engine life cycle. They forgo much risk.

It might then appear that the third-party independent maintenance, repair and overhaul (MRO) company has some challenges ahead. In populous markets there is still a significant number of engines operating away from OEM LTSAs, and as OEMs change strategy from CFM International CFM56-5B/-7B to LEAP-1A/-1B, or IAE V2500-A5 to Pratt & Whitney PW1100G, there remains a large number of previous-generation engines to maintain. Third-party MROs have been increasing their capabilities in those markets and many are offering similar tailored long-term aftermarket solutions.

An area of growth has been with some airline MROs. Examples include Delta TechOps, as well as other long-time engine MRO providers AF KLM E&M and Iberia Maintenance. An astounding example of the in-house benefits comes from Delta TechOps. During 2010, the airline had more than 5,000 maintenance-related service cancellations, whereas now, this figure is just over 100 a year. While not all of them relate to delays caused by engine faults, it emphasises the benefits to a large airline.

Delta TechOps explains this as enhancements in skilled personnel, training, infrastructure, big data and predictive maintenance, logistics, document management and greater MRO offerings. The growth of Delta TechOps' engine services has attracted the likes of Rolls-Royce (vice-versa), thus increasing Delta TechOps' engine capabilities further giving it a unique market position servicing engine types traditionally reserved for the OEM.

Iberia Maintenance, guided by International Airlines Group's (IAG) strategy, is transforming its engine MRO shop to offer a more competitive suite of engine maintenance services for all IAG airlines to enable greater insourcing of engine maintenance. Do not assume, though, that both Delta TechOps and Iberia Maintenance only prioritise their own fleets; this is not the case and external growth has been apparent.

Supporting the respective growth is a new test cell and Rolls-Royce Trent 7000 licensing for Delta TechOps, and prospective CFM LEAP-1A licensing for Iberia Maintenance.

For the third-party independent, growth in capabilities has not been as expansive. However, it has been concentrated for popular types, and there are many encouraging developments. Maintenance cost, best exhaust gas temperature margins, repair over replace, used serviceable materials, are all common taglines and there is substance. Aero Norway has seen significant sales growth, increasing capacity, and engine induction shifts away from CFM56-3 to the later CFM56-5B and CFM56-7B models.

Complementing this growth is the ability for the company to perform 90% of all its current repair coverage in-house; repair coverage it estimates has grown 20% annually.

This is not an isolated trend. At the neighbouring Helsinki airport, GA Telesis Engine Services has performed services since the takeover of the former Finnair Engine Services business in 2017, again increasing its stock for an all-encompassing aftermarket service offering. It even has a specialised nacelle maintenance programme.

In Miami, entities such as Global Engine Maintenance have moved away from JT8D maintenance to focus on current and future populous markets such as the CFM56-5B and CFM56-7B, where piece parts, module building and location enables shop visit cost savings.

> *"To date, Pratt & Whitney and CFM International have undoubtedly achieved what they set out to do with LTSA shares increasing on new-build engines."*
>
> **Kane Antony Ray**, senior consultant, Counterpoint Market Intelligence

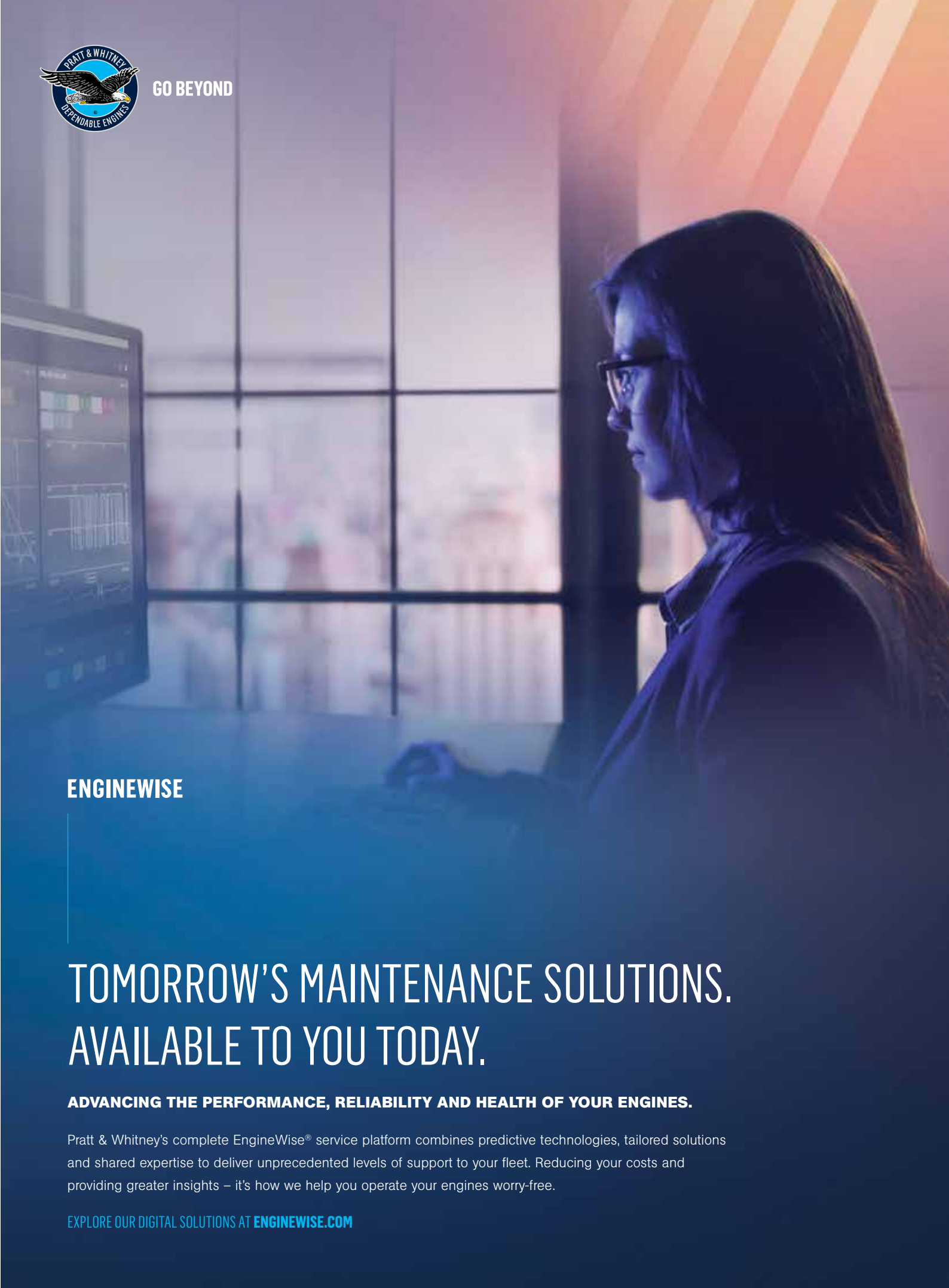
Third-party independents are not just MROs either. Their facilities and capabilities comprise test cells for maximum power assurance testing, machining centres, component stores, piece part repair, field services, engine sales, trades and exchanges, as well as engine leasing and component consignment services. The capabilities are attractive for their own LTSAs too.

Aside from the one-stop shops, there are also niche offerings available that have been incredibly successful, established as a result of other maintenance experience, component supply and even manufacturing.

GKN Aerospace repairs 67,000 fan blades annually, covering about 16 engine types. Its main customers are engine OEMs and engine MROs. Others that are not so established include Dublin Aerospace and its recent capability addition for integrated drive generator overhauls. There remain new opportunities.

Many independents have or are reacting to the demands of the engine users or owners with single-aisle engine coverage. Costs attributed to twin-aisle engine coverage and historical OEM control mean that very few have strategies to incorporate such capability. If there are not already existing in-house MRO capabilities, CFM's CFM56-5B and CFM56-7B and, to a lesser extent, International Aero Engines' V2500-A5, are still being sought by independents.

While it is more competition, it is also much needed extra capacity, and with potential cost benefits for end users.



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No furlough for MROs

Magellan Aviation Group is optimistic its growth strategy will survive the latest crisis, writes David Rushe, the engine lessor and support company's director of sales and marketing, EMEA.

The engine aftermarket sector in 2019 was dominated by supply chain challenges, delivery delays and capacity constraints. All of this was taking place in a macro environment with trade wars, geopolitical uncertainty and environmental scrutiny to the fore.

These effects have since been dwarfed by the impact of the Covid-19 pandemic, which has set in motion flight cancellations and capacity reductions at an unprecedented scale. The long-term consequences of this sudden downturn in passenger traffic remain to be seen.

Before this, the engine maintenance, repair and overhaul (MRO) and aftermarket sector was very much in a growth phase with compound annual growth rate of about 5% projected to the end of the 2020s. The appetite for continued service of mid- to end-of-life aircraft has also been helped by manageable fuel prices, which as of March 2020 were about 60% down compared with 2019 averages.

Spare parts and green-time leasing demand across Magellan's core engine types continues to see growth and our acquisition strategy into 2020 reflects our confidence that this trend will continue in the medium term, notwithstanding the impact of Covid-19.

Magellan's business model focuses on two core areas – engine and airframe used serviceable materials (USM) and engine leasing. The Magellan engine lease pool consists of about 60 engines with the core types being the Pratt & Whitney PW127 and PW150, the General Electric CF34-8, CFM56-5/7 and PW4000 models.

While more than 1,000 Airbus A320neo-family aircraft are now in service globally, with up to 700 provisionally scheduled to enter service by the end of 2020, we are yet to see a negative impact on CFM56-5B and V2500-A5 spare parts demand. The CFM56-7B spare parts market is even more buoyant. Engine shop visit slot availability across these three narrowbody engine types was at a premium in 2019 – partly because of some unscheduled removals and modification factors, but also as the industry seemed finally to witness a long-awaited bow wave in shop visits.

> *"Spare parts and green-time leasing demand across Magellan's core engine types continues to see growth and our acquisition strategy into 2020 reflects our confidence that this trend will continue in the medium term, notwithstanding the impact of Covid-19."*
>
> **David Rushe**, director of sales and marketing, EMEA, Magellan Aviation Group

On the regional engine side, Magellan is seeing similar demand for aftermarket material for CF34-8C/8E parts. On the widebody side, Magellan's core focus is on the PW4000 series of engines as well as the CFM56-5C, both of which are in the sunset phase in terms of operation, yet spare parts demand remains healthy.

Acquiring engines to support this MRO demand has been the challenge. An influx of new aftermarket entrants driven by low financing costs and private equity investment as well as original equipment manufacturers (OEMs) and MROs looking to source engines for their respective supply chains and lifecycle supply agreements had contributed to what is very much a seller's market.

The Magellan engine lease pool consists of about 60 engines

Despite the induction delays with new-technology aircraft and propensity for airlines and lessors to extend leases to bridge capacity gaps, there was no shortage of assets offered for part-out in 2019 and into 2020. The high demand for part-out airframe and engine assets in the past few years has contributed to inflated asset pricing, much of which came from the coffers of new market entrants. Again, A320/Boeing 737NG powered by CFM56-5B/7B and IAE V2500-A5 assets were the most inflated in terms of sale prices.

With more than 40% of CFM56-5B/7B and over 35% of V2500-A5 engines yet to have their first shop visit, it is difficult to envisage owners and operators of these engines seeking end-of-life solutions for their assets. However, it must be noted that the CFM56-5B and V2500-A5 have been in production for more than 25 years while the -7B has been in production for over 22 years.

Life limited part (LLP) limits, reduced on-wing intervals and mature-life maintenance intervals are typical factors to drive up ownership costs as engine fleets age. However, market demand for these three types is also facing pressure from replacement technology engines coming onstream. Whereas OEM and MRO flight-hour support contracts and lease agreements will often dictate maintenance inputs in younger engines, owners of older more mature engines will look to avoid shop visits or reduce shop visit input costs to keep their assets flying economically.

Mature heavy shop visit costs can be well in excess of $3 million for the V2500-A5, less LLP replacement, and more than 90% of this spend can be for material inputs. The incorporation of USM material offers significant savings versus new material, particularly in the core of the

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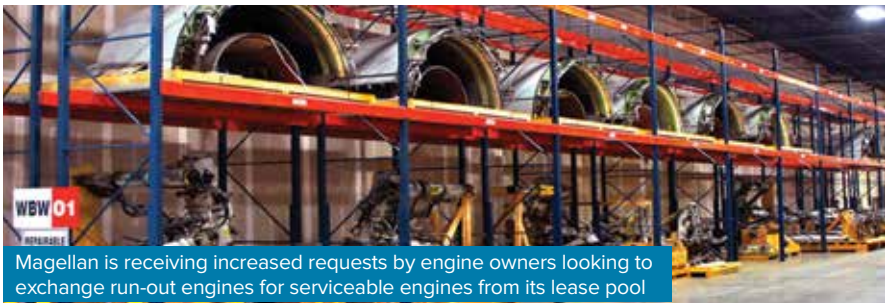

Magellan is receiving increased requests by engine owners looking to exchange run-out engines for serviceable engines from its lease pool

engine as well as high cost components such as fan blades and high-pressure turbine (HPT) blades, which can often be vulnerable to scrap in later life.

In terms of LLP replacement, there are significant cost savings in buying overhauled part-life LLPs from the aftermarket rather than acquiring new, full-life sets. Avoiding such shop visit costs altogether is also achievable by leasing in a substitute engine to cover the predicted utilisation of the host aircraft, and selling the removed engine on the market. Magellan is receiving increased requests by engine owners looking to exchange run-out engines for serviceable engines from its lease pool.

Taking a look at three core product types inherent to Magellan's part business and lease pool – the CF34-8E, CFM56-5B and PW4000-112 – some of the market trends evident in the mature engine market can be explained. Market conditions for the CF34-8E are obviously intrinsically linked to those of the host aircraft – the Embraer 170/175 models. Magellan has developed its CF34-8E lease pool and inventory of parts through the acquisition of whole aircraft as well as standalone engines from the market. The host aircraft family, despite having an average age of just 6.7 years, is undergoing some transition as operators take delivery of new-technology aircraft. It is notable that more than 82% of the E170/175 aircraft fleet is based in North America where operators take a more conservative view of regional jet fleet replacement.

The CF34-8E aftermarket is dominated by the presence of the OEM, General Electric, through its network of MROs, lifecycle support agreement and engine lease pool. Recent years have seen buoyant leasing demand for CF34-8E engines. This is driven by a number of factors, not least continued reliability issues relating to the HPT leading to unscheduled engine removals, driving lease demand.

A narrow shop network and slot congestion has exacerbated this issue. The increase in shop visit removals has also driven up USM consumption. There is evidence of CF34-8E owners acquiring engines outright because trading values are often below the cost of putting an engine through the shop.

As A220 and Embraer E-Jet E2 aircraft hit the market, E170/175 owners have been quite aggressive in marketing aircraft into emerging markets, where older regional aircraft are still in service, prolonging engine lease demand. The prevalence of the E170/175 within the fleets of the North American majors is deep-rooted in scope clause provisions, which limit and dictate the proportion and capacity of regional aircraft flying in tandem with mainline narrowbody aircraft. It is notable that the newer technology E-Jet E2 and Mitsubishi SpaceJet have seen North American placement opportunities limited by scope clause arrangements.

The CFM56-5B powers about 56% of the delivered A320 classic family and more than 60% of the low-mid-thrust A319 and A320 models. The rival V2500-A5 sits on 60% of the A321 fleet.

Even though 2020 is the last year of CFM56-5B production for civil aircraft, annual USM demand is growing exponentially. The type has a wide MRO network and a diverse operator base. As of March, Magellan recorded a -5B installed fleet of some 3,800 aircraft. Shop visits are projected to reach a peak in the early 2020s with more than 40% of the fleet yet to have its first shop visit.

The year 2018 and the first half of 2019 saw lease demand for the -5B model outstripping supply because of underlying shop visit demand being further congested because of HPT front air seal cracking issues. Since then, the market has returned to equilibrium for mid-thrust -5B engines; however, the growth of the A321 freighter conversion market has seen -5B3 demand outstripping supply.

Magellan has seen sustained lease demand for its lease pool of -5B3 engines at very aggressive rental rates and this trend is set to continue. There has been a reverse in demand for low-thrust -5B models, as the A319 begins to market demand impact by operators looking for higher capacity or newer technology assets. Indeed, the vast majority of teardown engines hitting the market have been -5B6 models. Despite the large number of first-run engines on the market, Magellan has seen evidence of -5B operators and lessors seeking engines for lease to avoid expensive shop visits as engines reach the mature phase of operation. Magellan has maintained strong links with Pratt & Whitney throughout its history and this is evident in the prominence of the PW4000 engine in our lease pool. Magellan has added PW4000-112-inch engines, which power the 777-200/ER and -300 aircraft models, in the past few years. This engine model is out of production and the host aircraft type, having been superseded by the 787 and A350 models, is witnessing falling demand.

About 174 PW4000-powered 777s were built with a fleet of about 130 aircraft in service today. Operators such as All Nippon Airways, Air China and Vietnam Airlines have all phased out aircraft in recent years and just seven operators are now operating the engine.

The OEMs dominate the engine MRO and leasing space and the high volumes of PW4000-94 engines with common parts which have been disassembled has helped to reduce material input costs in shop visits. Recent years have seen a narrow shop network, high mature shop visit costs and reduced reliability across an ageing fleet contribute to a ramp-up in short- to mid-term PW4000-112 leasing demand. It is possible to acquire a green-time engine for a fraction of the cost of a heavy shop visit, which makes economic sense for operators of the PW4000-112, many of which are looking to phase out the host aircraft in the next five years.

Looking at the three engine types, there are common trends that Magellan is seeing across the leasing and USM market for current-production engines, regardless of where they are in the lifecycle. Again, the outlook is predisposed by Covid-19, but as the CF34-8E and CFM56-5B enter the mature phase, there is an increased propensity for USM material to minimise shop visit costs and build cycles.

Simultaneously, the market could see an increase in short- to mid-term engine leasing as a cost-effective means of avoiding shop visits for engines where extensive hardware and LLP replacement is required.

Leasing demand should remain solid across the PW4000 fleet and as the global fleet continues a gradual decline, serviceable green-time engines will be in high demand to keep costs down.

Looking ahead to the next phase of technology coming onto the market, the induction issues with certain CFM International LEAP and PW1000G engine models coming onstream will likely contribute to a surplus of spare engine availability in the latter half of this decade – we saw this with the V2500 Stage 3-8 Drum issue in the late 2000s. So, it is quite possible that Magellan will be adding these surplus spare engines to our lease pool sooner than envisaged.

The impact of Covid-19 on engine lease rates

Graeme Crickett, chief technical officer of SMBC Aero Engine lease, predicts tough times for the widebody engine market, particularly larger models.

The impact of Covid-19 is still developing but on the face of it today, it would be fair to say the resulting fallout will be substantial, widespread and a major correction to the world, which of course, the aviation industry plays a substantial part in.

IATA currently projects that of the 700 commercial airlines it rates, only 30 can survive the resulting fallout without some form of government support. Quite a sobering statement.

The industry has long had swings and corrections and the old hands still around will probably be more familiar with the fluctuations than the more recent people in the leasing community.

The current market has had a very strong run, not only with some of the cheapest finance for many years, but also the sheer quantity that could be termed a flood.

Investors have brought little with much of the cheaper money they have used other than an absence of relative experience. It was like the expectation was that nothing could go wrong.

Well, like all corrections, the current one is swift, un-forecasted (where are all those risk managers) and will be brutal.

For years, airlines have enjoyed the influx of cheap money and highly competitive bids for sale and leaseback (SLB) opportunities. Even the poorer credit airlines were getting rates and benefits way out relationship to reality. Not only have they luxuriated in ultra-low lease rate factors, they also managed to obtain no maintenance reserves payments, no covering letter of credit options.

The chance of this situation continuing in the current environment is precisely zero.

The leasing community cannot carry the weight of non-payments for very long and for the industry to move on, any future deals will inevitably include a significant level of security deposit. Some measure of maintenance consumption offset will also be needed.

Prior to the current crisis, airlines typically negotiated full list prices for engine SLB deals, with minimum security deposits (usually one-month or a letter of credit equivalent), no maintenance reserves, airworthiness directives compliance contributions and back end of the lease value adjustments.

“This industry is one of the most complicated operations in the world.”

Graeme Crickett, chief technical officer, SMBC Aero Engine lease

Lease rate factors ranged between 0.50% to 0.60% roughly, depending on which leasing company was bidding and how aggressive they were.

While taking advantage of the situation, airlines did very well out of the surfeit of cheap funds and a measure of desperate lessors trying to grow portfolios, or just too much inexperience - some might say a possible mixture of all of these points.

Covid-19 impact on engines

The length of the aviation tumble ranges from two-three months to three-four years, especially for international travel.

What is plain is that nearly every country has a different response, rules and regulations, and totally uncoordinated with even their nearest neighbours. It appears that the USA can’t even coordinate between the States effectively. So it is hard to imagine everyone resuming normal all at the same time.

There will be airlines that fail, airlines that shrink, airlines that merge (perhaps not that many), but the overwhelming thought is that the widebody aircraft are in trouble unless they are freighters.

Large engine leasing market will be a little more problematic as the grounding of the majority of fleet will force airlines and lessors to make decisions prematurely in order to survive.

This means the likelihood of early retirement aircraft, multiple engines removed from wings and introduced into the spare engine leasing market or reduction to parts.

Certainly the GE90-115B engine could well benefit from a potential used serviceable materials (USM) market as the current shop visit costs are just astronomical. Typically, the second performance restoration could easily hit $16 million in some circumstances.

Lease rates for these widebody aircraft engines will likely plunge. Lease rate factors will be immaterial other than to the successful lessor, who knows the actual book value of the engine.

Everyone else will be talking about the “monthly rent” in a similar manner to the short-term or green time type lease.

With international travel down, the smaller widebodies will be more logical to be operated while the big aircraft like the Airbus A380s, Boeing 777s and A350s will be subject to significant pressure. Values of these aircraft are probably going to take a beating for the foreseeable future.

The green-time type lease such as we see in engines like the CFM56, V2500-A5 and other diminishing models like the CF6-80C2, PW4000, RB211-535 will face a big problem to recover as the airlines (per previous downturns), simply stop leasing and start to exit the older aircraft earlier than previously planned.

Up until early 2020, these types of lease were quite buoyant. Rents were around the $60,000 per month for average engines, a little more for better ones and terms could run to 3-4,000 cycles.

Maintenance repair and overhaul companies (MROs) such as MTU, Lufthansa Technik, Rolls-Royce all played in this market, some in support of their MRO operations and at other times, they just lease into the independent market.

These types of leases have collapsed as airlines have simply grounded their fleets and returned as many engines as they can.

For the Neo models the pressure is still on them to produce profitable returns. The fuel pricing makes this margin a problem. More pressure will return on the OEMs to develop fixes for the on-going problems that continue to plague the types.

The Max is unlikely to return to service before the third quarter of 2020 and quite possibly into the fourth quarter. These will need nearly every engine put back into some shop visit event to restore serviceability and confidence of reliability to not only operators but the passenger market specifically.

Lease rates for the Neo models will rise and the OEMs will come under pressure to stop giving away low maintenance rates that do not fully cover the potential shop visit events. This is good news for the engine leasing community, which has argued over the years that the rates the airlines demanded were just not based on reality. They were based on market share negotiations with the OEMs. This needed to stop as the aviation industry must pay its way in the real world.

It would be nice if the airlines stopped giving away profits in the chase to the bottom for passenger revenue. What it has produced is a shallow resilience to market influences.

The present environment for engine SLBs is still a learning curve on both sides. The cost of finance (or cash) for everyone is unstable. For some airlines, the interest rates are 8-13% therefore a SLB transaction is potentially a good deal if they can negotiate a better cost (and cash).

Airlines who mandated parties as late as February or March 2020 have seen the deal collapse as the unstable finance resulted in a wide spread of interest rates. While the swap rates are low, the finance industry has swiftly built in an aviation risk factor that many in the airlines either don't see or don't want to see or acknowledge it.

Some airlines, who haven't traditionally been engine lessees are now considering raising cash by way of the SLB process and with volume portfolios.

The trading environment is in about the same condition as the rest of the engine market. Parts sales to MROs have stopped, airlines have frozen current and future shop visits so the demand has dropped off.

The probable trading market will be between leasing companies as a way of producing a trading profit. This happened many years ago but it fell off due to the competitive nature of each leasing company not wanting to share documentation as well as customers. Selling to third party financiers was favoured.

The current situation is not expected to support third party financiers particularly well as the market will be hard on cash flows and with this drying up, so will the appetite for this kind of risk.

So the monthly rent and credit risk exposure is something genuine engine leasing companies are good at understanding as well as estimating.

The bigger leasing companies who have larger structures and more expansive head counts, may have issues with substantial portions of their portfolios on the ground, non-income generating, this will be a stressful time. Leverage back to their source of finance (be that parent companies or structured banks) will be critical.

For a number of OEM-based engine lessors who have a decent percentage of their portfolio as a more strategic position that may have a poorer return than the more competitive deals they have under contract, the need to trade will be a lot higher than the less leveraged competitor. The ones with securitised funding cannot hold out once the cash flow dries up.

So expect a number of trading opportunities to be sought between specialised engine lessors.

The last great downturn saw the combined profits of the world airline industry, since the Wright brothers fell off a sand dune at Kittyhawk, was effectively in the negative. With the latest world issues, I think we are back to this position again.

What the long-term will bring the aviation industry is just a guess. This industry is one of the most complicated operations in the world, with a very large number of external influences such as regulations, politics, finance, operations (both regional, domestic and international) and egos all have a vote in this democracy. But it is going to be an interesting ride, so buckle up, the going will be rough.

Please note the article is based on the author's opinions and do not necessarily reflect those of SMBC Aero Engine Lease.

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Engines attract investors in capital markets

Asset-backed securities are becoming a popular financing tool in the engine market, writes **Olivier Bonnassies**.

The asset-backed securities (ABS) market opened in 2020 with two transactions including engines only. The typical financing structures used by airlines when acquiring engines are bank debt and operating leases.

Engine leasing and aftermarket companies have added engines in their portfolio using warehouse facilities and revolving credit facilities. But two leasing companies, Willis Lease Finance and Total Engine Support, used the capital markets as a financing tool for a total of $633 million in refinancings in the first quarter of 2020.

Mastering ABS refinancings

In the past, Willis Lease Finance was the only engine entity issuing debt in the ABS market, via special purpose vehicles.

The US lessor has a pipeline of ABS deals through its subsidiary, Willis Engine Securitization Trust (WEST), entities which have demonstrated that Willis Lease is more than an engine lessor.

Since August 2017, Willis Lease has closed three ABS issuances – WEST III, WEST IV and WEST V – raising more than $1 billion of new debt.

Its latest deal, WEST V, used the proceeds of the $366 million notes to repay in full the aggregate principal amount of outstanding Class 2012-A fixed-rate term notes issued by WEST II in 2012, including 29 aircraft engines.

On 17 September 2012, WEST II issued $390 million senior class of single notes, at a fixed-rate coupon of 5.5%, with a 10-year term.

The WEST II notes were initially secured by 79 engines acquired at 70% loan-to-value (LTV). The innovation on that transaction included a lock-in fixed interest rate on the notes, providing certainty of future cash flows.

Proceeds from the single tranche notes were used to repay the (at the time) existing notes of WEST.

WEST V issued three tranches, with $303 million of series-A notes at 3.23%, $42.1 million of series-B notes at 4.21% and $21.1 million of series-C notes at 6.65%. The LTV was 72%, 82% and 87%, respectively. As with previous transactions, Willis Lease Finance retained the equity in WEST V. BofA Securities was the structuring agent, while Bank of America was the liquidity facility provider. Deutsche Bank was the trustee and security trustee in the transaction.

Another portion of the new debt deal was used to acquire 25 aircraft engines and three Airbus A319 airframes. In total this represented 57 assets: 48 spare engines, and three aircraft consisting of three airframes and six engine assets. At the time of the issuance, 53 of the 57 assets in the portfolio were on lease to 24 lessees. Four engines were not subject to a lease agreement.

As of 15 January 2020, the portfolio had a remaining lease term of about 23.7 months, with about 10.5% of the portfolio initially not subject to a lease. The three 2006-vintage A319 airframes, representing 3.2% of the portfolio, are leased to Easyjet through to 2022. The portfolio has an initial value of about $420.9 million, based on the average of the maintenance-adjusted base values provided by three appraisers for the portfolio.

As of February 2020, Willis Lease owned 262 aircraft engines and 12 aircraft (including the assets in the initial portfolio, WEST IV, WEST III and WEST II). In addition, Willis and its affiliates manage a portfolio of more than 400 aircraft engines and related equipment for third parties.

In the first three months of 2020, ABS transactions across five issuances totalled $2.26 billion – a quarter of last year's total. This compared with one issuance, MAPS 2019-1, over the same period in 2019.

Inaugural ABS

Total Engine Asset Management (TEAM), the joint venture between ST Engineering and Marubeni, launched Sunbird 2020-1, its inaugural securitisation, in the first quarter of 2020.

Sunbird Engine Finance Limited and Sunbird Engine Finance LLC issued $256.98 million in three tranches: $214.14 million series-A notes have a 70% LTV; $30.6 million series-B notes have an 80% LTV; and $12.24 million series-A notes have an 84% LTV.

The transaction included about $81.3 million in E-notes. KBRA, which rated the notes at A, BBB and BB, respectively, noted the initial owners of the equity as TEAM (at least 10%) and an affiliate of Marubeni (at least 40%), with the balance going to one or more third parties.

Citigroup Global Markets acted as sole structuring agent and joint lead bookrunner. Credit Agricole-CIB acted as joint bookrunner. The initial liquidity facility provider is Credit Agricole-CIB. TEAM is the servicer of the portfolio.

Proceeds from the notes are used to acquire 30 commercial jet aircraft engines on lease, or subject to a letter of intent to be leased, to 13 lessees.

As of 31 January, the initial weighted average remaining lease term was about 5.9 years.

The portfolio consists of 29 engines powering narrowbody host aircraft, consisting of eight CFM56-5Bs, 11 CFM56-7Bs, four LEAP-1As, one PW1127G-JM, four V2527-A5s and one V2533-A5. One widebody engine, a GE90-115B, is also included in Sunbird 2020-1.

The portfolio has an initial value of about $305.9 million, based on the average of the half-life base values provided by three appraisers as of the fourth quarter of 2019 and adjusted for maintenance conditions as determined by Alton Aviation Consultancy.

The TEAM transaction essentially includes narrowbody host aircraft (90% of the collateral) while WEST V is more in line with previous Willis Lease ASB deals: about 75% narrowbody host aircraft, about 18% of widebody host aircraft, while the remainder consists of regional host aircraft and airframes.

WEST V's largest lessee is General Electric Company with 12.5%, followed by Easyjet with 11.1% and KLM Royal Dutch Airlines with 6.1%. Sunbird is more concentrated on low-cost carriers with Frontier (26.6%), Lion Air (18.3%) and SpiceJet (10.2%).

In Willis ABS transactions, the top three lessees typically represent 27% to 29% of the lessees. Sunbird's top three lessees represent 55% of the lessees.

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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	$0.430m	$0.430m	$25,000	$0.025 - $0.100	$3.500m	$1.320m	9,000	1.4
CFM	CFM56-3B2	$0.430m	$0.430m	$25,000	$0.025 - $0.100	$3.500m	$1.390m	8,000	1.4
CFM	CFM56-3C1 - 23.5k	$0.780m	$0.780m	$25,000	$0.025 - $0.100	$3.500m	$1.450m	7,000	1.4
CFM	CFM56-7B22	$3.450m	$3.450m	$55,000	$0.600 - $1.800	$4.010m	$3.130m	24,000	1.8
CFM	CFM56-7B24	$4.070m	$4.070m	$64,000	$0.600 - $1.800	$4.010m	$3.050m	22,500	1.8
CFM	CFM56-7B26	$4.930m	$4.930m	$72,000	$0.600 - $1.800	$4.010m	$3.010m	20,600	1.8
CFM	CFM56-7B24E	$6.750m	$6.750m	$63,000	$0.600 - $1.800	$4.010m	$3.420m	26,000	1.8
CFM	CFM56-7B26E	$7.670m	$7.670m	$73,000	$0.600 - $1.800	$4.010m	$3.330m	24,000	1.8
CFM	CFM56-7B27E	$8.160m	$8.160m	$86,000	$0.600 - $1.800	$4.010m	$3.300m	23,000	1.8
CFM	CFM56-5B5/P	$3.460m	$3.460m	$50,000	$0.700 - $2.300	$4.120m	$3.130m	22,400	1.7
CFM	CFM56-5B4/P	$4.710m	$4.710m	$70,000	$0.700 - $2.300	$4.120m	$3.110m	21,400	1.7
CFM	CFM56-5B4/3 PIP	$6.870m	$6.870m	$80,000	$0.700 - $2.300	$4.120m	$3.240m	24,500	1.7
CFM	CFM56-5B3/P	$5.240m	$5.240m	$65,000	$0.700 - $2.300	$4.120m	$2.920m	17,700	1.7
CFM	CFM56-5B3/3 PIP	$7.530m	$7.530m	$77,000	$0.700 - $2.300	$4.120m	$3.270m	21,500	1.7
CFM	CFM56-5C4/P	$1.450m	$1.450m	$45,000	$0.100 - $0.800	$4.190m	$2.760m	13,500	6.0
EA	GP7200	$7.500m	$8.000m	$120,000	$1.100 - $1.900	$9.120m	$6.830m	20,000	8.0
GE	CF34-3B1	$1.085m	$1.085m	$27,500	$0.185 - $0.500	$2.100m	$1.120m	11,500	1.3
GE	CF34-8C5	$2.810m	$2.810m	$40,000	$0.500 - $0.600	$3.080m	$1.650m	11,000	1.3
GE	CF34-8E5	$3.280m	$3.280m	$41,000	$0.800 - $0.900	$3.080m	$1.650m	11,000	1.3
GE	CF34-10E6	$4.860m	$5.060m	$67,000	$1.370 - $1.900	$2.760m	$2.320m	13,000	1.3
GE	CF6-80C2B6F	$2.480m	$2.480m	$150,000	$0.300 - $0.600	$8.690m	$4.450m	16,000	6.0
GE	GEnx-1B74/75/P2	$21.290m	$21.290m	$245,000	$1.800 - $4.200	$10.100m	$6.730m	19,500	6.0
GE	CF6-80E1A3	$9.360m	$9.360m	$135,000	$1.300 - $2.500	$12.360m	$5.030m	15,000	5.0
GE	CF6-80C2D1F	$1.530m	$1.530m	$120,000	$0.300 - $0.600	$8.690m	$4.450m	16,000	6.0
GE	GE90-115BL	$16.890m	$18.579m	$235,000	$1.200 - $2.500	$14.390m	$10.940m	19,000	7.5
GE	CF6-80C2B1F	$1.970m	$1.970m	$120,000	$0.300 - $0.600	$8.690m	$4.450m	16,000	6.0
IAE	V2527-A5	$4.810m	$4.810m	$78,000	$0.700 - $2.500	$4.310m	$3.580m	16,400	2.0
IAE	V2527-A5 Select	$5.830m	$5.830m	$73,500	$0.700 - $2.500	$4.310m	$3.800m	19,300	2.0
IAE	V2533-A5	$5.650m	$5.650m	$74,000	$0.700 - $2.500	$4.310m	$3.670m	11,200	2.0
IAE	V2533-A5 Select	$6.970m	$6.970m	$82,500	$0.700 - $2.500	$4.310m	$3.620m	13,600	2.0
PW	JT8D-219	$0.190m	$0.190m	$20,000	$0.070 - $0.080	$2.330m	$2.070m	9,000	1.5
PW	PW4060	$2.240m	$2.240m	$55,000	$0.300 - $0.600	$7.970m	$5.690m	17,500	6.0
PW	PW4168A	$3.800m	$3.800m	$90,000	$0.700 - $1.800	$10.120m	$7.440m	17,000	6.0
PW	PW4090	$5.900m	$5.900m	$137,500	$1.000 - $2.500	$16.670m	$11.710m	19,000	7.0
RR	AE3007A	$0.640m	$0.640m	$22,500	$0.085 - $0.280	$2.120m	$1.240m	8,450	1.3
RR	Tay 650-15	$0.780m	$0.780m	$25,000	$0.100 - $0.300	$1.910m	$2.170m	11,000	1.1
RR	BR715A	$2.500m	$2.500m	$40,000	$0.300 - $0.900	$2.440m	$2.480m	12,300	1.6
RR	RB211-535E4	$3.130m	$3.130m	$45,000	$0.450 - $0.900	$6.150m	$5.070m	22,000	3.1
RR	Trent 1000-J2	$17.290m	$17.290m	$170,000	N/A	$7.950m	$7.870m	25,000	6.9
RR	Trent 772B-60EP	$8.400m	$8.400m	$105,000	$2.000 - $2.050	$9.750m	$9.520m	26,200	4.4
RR	Trent 895	$7.590m	$7.990m	$145,000	N/A	$12.190m	$9.830m	20,500	5.4
RR	Trent 556-61	$2.820m	$3.130m	$95,000	$0.200	$9.330m	$6.930m	22,000	8.4
RR	RB211-524H-T	$1.710m	$1.710m	$27,500	$0.200 - $0.700	$6.470m	$6.830m	24,250	6.5
RR	Trent 970	$11.500m	$12.250m	$125,000	$0.600	$10.710m	$7.870m	23,000	8.8

Source: IBA, April 2020

Aircraft Model	Engine Options
1900C	PT6A-65B
1900D	PT6A-67D
340A	CT7-5A2
340B	CT7-9B
717-200	BR700-715C1-30
	BR700-715A1-30
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
	CFM56-7B20/3
	CFM56-7B22
	CFM56-7B22/3
	CFM56-7B22E
	CFM56-7B22E3
	CFM56-7B24
	CFM56-7B24/3
	CFM56-7B24E
	CFM56-7B26
	CFM56-7B26E
737-700BDSF	CFM56-7B22
	CFM56-7B24
737-8	LEAP-1B25
	LEAP-1B28
	LEAP-1B27
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
737-800BCF	CFM56-7B24
	CFM56-7B26
	CFM56-7B27
	CFM56-7B27/B1
737-9	LEAP-1B25
	LEAP-1B28
737-900	CFM56-7B24
	CFM56-7B26
737-900ER	CFM56-7B26/3
	CFM56-7B26E
	CFM56-7B27
	CFM56-7B27/B1
	CFM56-7B27E
737BBJ1	CFM56-7B26
	CFM56-7B27
	CFM56-7B27/3
	CFM56-7B27/3B1
	CFM56-7B27E
737BBJ2	CFM56-7B27
737BBJ3	CFM56-7B27
737MAXBBJ2	LEAP-1B28
747-200F	CF6-50E2
	JT9D-7R4G2
	RB211-524D4
747-300	CF6-50E2
747-400	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	RB211-524G/H-T
	RB211-524H2
747-400BCF	CF6-80C2B1F
	PW4056
747-400ERF	CF6-80C2B1F
	CF6-80C2B5F
	PW4062
	PW4062A
747-400F	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	PW4062A
	RB211-524G/H-T
	RB211-524H2T-19
	RB211-524HT
747-400ISF	CF6-80C2B1F
	PW4056
747-400LCF	PW4056
747-400M	CF6-80C2B1F
747-8	GENX-2B67
	GENX-2B67B
747-8F	GENX-2B67
757-200	PW2037
	PW2040
	RB211-535E4
	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	CF6-80A2
	CF6-80C2
	CF6-80C2B4F
	CF6-80C2B6F
	JT9D-7R4D
	JT9D-7R4E
	PW4056
767-200ERF	CF6-80A2
	CF6-80C2B2
	CF6-80C2B4F
767-200F	CF6-80A
	CF6-80A2
	CF6-80C2B2F
	JT9D-7R4D
767-300	CF6-80C2B2F
	CF6-80C2B4F
767-300ER	CF6-80C2B2
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7F
	PW4052
	PW4056
	PW4060
	PW4062
	RB211-524H
	RB211-524HT
767-300ERF	CF6-80C2B2
	CF6-80C2B5F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
	PW4060
	PW4062
767-400ER	CF6-80C2B8F
	CF6-80C2B8FG01
777-200	GE90-90B
	PW4077
	PW4084
	TRENT 875-17
777-200ER	GE90-90B
	GE90-92B
	GE90-94B
	PW4074D
	PW4090
	TRENT 892-17
	TRENT 892B
	TRENT 892B-17
	TRENT 895
	TRENT 895-17
	GE90-85B
777-200LR	GE90-110B1L
777-200LRF	GE90-110B1
777-300	PW4090
	TRENT 892
	TRENT 892-17
	TRENT 892B
	TRENT 892B-17
777-300ER	GE90-115B
777-8	GE9X
777-9	GE9X-105B1A
787-10	TRENT 1000-J
	GENX-1B74
	TRENT 1000-TEN
	GENX-1B76
787-8	GENX-1B64
	GENX-1B67
	GENX-1B70
	TRENT 1000-A
	TRENT 1000-TEN
	TRENT 1000-D
	TRENT 1000-G
	TRENT 1000-D2
787-9	GENX-1B70
	TRENT 1000-J
	GENX-1B74
	TRENT 1000-TEN
	GENX-1B76
	TRENT 1000-K
787teenager	TRENT 1000-A
	TRENT 1000-D
99	PT6A-20
	PT6A-27
	PT6A-28
99A	PT6A-27
	PT6A-27A
	PT6A-28
A220-100	PW1524G
	PW1519G
	PW1521GA
A220-300	PW1524G-3
	PW1521G-3
A300-600	CF6-80C2A3
A300-600F	PW4158
A300-600R	CF6-80C2A5
	CF6-80C2A5F
	PW4158
A300-600RF	CF6-80C2A5
	CF6-80C2A5F
	PW4158
A300B4-200F	CF6-50C2
A310-300	CF6-80C2A2
	PW4156A
A310-300F	CF6-80C2A2
	CF6-80C2A8
A318-100	CFM56-5B8/3
	CFM56-5B8/P
	CFM56-5B9/3
A318CJ	CFM56-5B9/3
	CFM56-5B9/P
A319-100	CFM56-5A4
	CFM56-5A5
	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
	V2527-A5
	V2527M-A5
	CFM56-5A5/F
A319CJ	CFM56-5B5/P
	CFM56-5B7/3
	CFM56-5B7/P
	V2527M-A5
A319neo	LEAP-1A24
	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
	V2527-A5
	LEAP-1A26CJ

Source: Avitas, April 2020

Aircraft Model	Engine Options
A320neo	LEAP-1A24
	LEAP-1A26
	LEAP-1A32
	PW1127G-JM
	LEAP-1A26E1
	PW1129G-JM
	PW1127G1-JM
A321-100	CFM56-5B1
	CFM56-5B1/P
	CFM56-5B2/P
	V2530-A5
A321-200	CFM56-5B1/3
	CFM56-5B1/P
	CFM56-5B2/3
	CFM56-5B2/P
	CFM56-5B3/2P
	CFM56-5B3/3
	CFM56-5B3/3B1
	CFM56-5B3/3P
	CFM56-5B3/P
	V2530-A5
	V2533-A5
A321CJ	CFM56-5B3/3
A321neo	LEAP-1A32
	PW1133G-JM
	LEAP-1A33
	PW1130G-JM
	PW1133GA-JM
A321neoACF	LEAP-1A30
	LEAP-1A32
	PW1127G-JM
	PW1133G-JM
	LEAP-1A33
A321XLR	LEAP-1A32
	PW1133G-JM
	LEAP-1A33
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
A330-300 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
	TRENT 772-60
A330-800neo	TRENT 7000-72
A330-900neo	TRENT 7000-72
A340-200	CFM56-5C2
A340-300	CFM56-5C2
	CFM56-5C3
	CFM56-5C3/F
	CFM56-5C4
	CFM56-5C4/P
A340-500	TRENT 556-61
A340-600	TRENT 556-61
	TRENT 556A2-61
A340-600CJ	TRENT 556A2-61
A350-1000	TRENT XWB-97
A350-900	TRENT XWB-84
A350-900CJ	TRENT XWB-87
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

Aircraft Model	Engine Options
ATR 42-600	PW127M
	PW127N
ATR 72-200	PW124B
	PW127
ATR 72-200F	PW124B
	PW127
ATR 72-500	PW127F
	PW127M
ATR 72-500F	PW127F
	PW127M
ATR 72-600	PW127M
	PW127N
ATR 72-600F	PW127M
AVRO RJ100	LF507-1F
	LF507-1H
AVRO RJ70	LF507-1H
AVRO RJ85	LF507-1F
	LF507-1H
B99	PT6A-27
	PT6A-27A
	PT6A-28
BAE 146-200	ALF502R-5
BAE 146-300	ALF502R-5
C-212-100	TPE331-5-251C
C-212-200	TPE331-10
C-212-300	TPE331-10R
C-212-400	TPE331-12JR
CRJ-1000	CF34-8C5A1
CRJ-100ER	CF34-3A1
CRJ-100LR	CF34-3A1
CRJ-200ER	CF34-3B1
CRJ-200LR	CF34-3B1
CRJ-700	CF34-8C1
	CF34-8C5B1
CRJ-700ER	CF34-8C1
	CF34-8C5B1
CRJ-900	CF34-8C5
	CF34-8C5A1
CRJ-900ER	CF34-8C5
CRJ-900LR	CF34-8C5
	CF34-8C5B1
DC-10-30	CF6-50C2
DHC-6-100	PT6A-20
	PT6A-27
DHC-6-200	PT6A-20
	PT6A-27
	PT6A-27A
DHC-6-300	PT6A-27
	PT6A-28
	PT6A-34
DHC-6-400	PT6A-34
	PT6A-35
DHC-7-100	PT6A-50
DHC-8-100	PW120A
	PW121
	PW121A
DHC-8-200	PW123C
DHC-8-300	PW123
	PW123B
	PW123E
DHC-8-400	PW150A
DO-228-100	TPE331-5
DO-228-200	TPE331-10
	TPE331-5
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	CF34-8E5A1G01
	CF34-8E5G01
E-190	CF34-10E
	CF34-10E5A1G07
	CF34-10E5G07
	CF34-10E6G07
E-190AR	CF34-10E
	CF34-10E5A1G05
	CF34-10E5A1G07
	CF34-10E5G07
	CF34-10E6A1G05
	CF34-10E6A1G07
	CF34-10E6G05
	CF34-10E6G07

Aircraft Model	Engine Options
	CF34-10E7G07
E-190E2	PW1919G
E-190LR	CF34-10E
	CF34-10E5A1G05
	CF34-10E5A1G07
	CF34-10E5G05
	CF34-10E5G07
	CF34-10E6A1G05
	CF34-10E6A1G07
	CF34-10E6G07
	CF34-10E7G07
E-195	CF34-10E5A1G07
E-195AR	CF34-10E5G07
	CF34-10E6G07
	CF34-10E7G05
	CF34-10E7G07
E-195E2	PW1921G
E-195LR	CF34-10E
	CF34-10E5A1G07
	CF34-10E5G07
	CF34-10E7G05
	CF34-10E7G07
EMB-110	PT6A-27
	PT6A-34
EMB-120ER	PW118
	PW118A
	PW118B
EMB-120FC	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
ERJ-145ER	AE 3007A
	AE 3007A1
	AE 3007A1/1
	AE 3007A1P
ERJ-145LR	AE 3007A
	AE 3007A1
	AE 3007A1/2
	AE 3007A1P
ERJ-145XR	AE 3007A1E
F100	TAY MK. 650-15
F27-500	DART 7 MK 535-7R
F50	PW125B
	PW127B
F70	TAY MK. 620-15
J31	TPE331-10U
J32	TPE331-12U
J41	TPE331-14G
	TPE331-14H
MD-10-10F	CF6-6
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-219
MD-87	JT8D-217C
	JT8D-219
MD-88	JT8D-219
MD-90-30	V2528-D5
MERLIN/METRO	TPE331-10U
	TPE331-11U
	TPE331-3U
MERLINIVC	TPE331-11U
METRO23	TPE331-12U
METROII	TPE331-10U
	TPE331-11U
	TPE331-3UW
METROIIIA	TPE331-11U
METROIIIB	TPE331-12U
MRJ90	PW1217G
S2000	AE 2100A
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 2020

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