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Engine LLPs

A balancing act between replacing LLPs and scheduled maintenance

A Critical Aspect of Engine MRO - Management of Life-Limited Parts

A balancing act between replacing LLPs and scheduled maintenance

By David Dundas

Every engine has to undergo a regularly scheduled overhaul based on its hours of use and the manufacturer's recommendations in order to adhere to safety regulations and maximise efficiency. However, a balancing act exists between scheduled maintenance and the replacement of life-limited parts, as there are times when the two do not coincide. Consequently, the management of life-limited parts becomes a critical element of engine MRO.

Dag Johnsen, Chief Operating Officer, Aero Norway

We were fortunate enough to be able to seek the opinions of nine industry professionals who were able to give us wide-ranging views on a number of topics related to the management of life-limited parts, the results of which make interesting reading.

What role do engine life-limited parts play when determining the work scope of an engine shop visit?

When an engine enters the shop, there are two types of shop visits: for performance restoration, or for LLP replacement. An engine overhaul is a multi-million-dollar expense for the operator. Smart work scoping is the key to balancing cost and a long on-wing time before the engine has to be removed again. Consequently, we specifically wanted to know what role engine life-limited parts play when determining the work scope of an engine shop visit. Anca Mihalache, Managing Director, AERO CARE advises that: "As shop visits are expensive, a good idea is to combine the two (if the LLPs are run out). This is called smart work scoping, and it means that the engines' owners manage to align LLP replacement timing with the engine's projected future use. For example, if an engine is expected to remain on-wing for a long interval post-shop visit, and the current LLPs would expire mid-cycle, it may be more cost-effective to replace them during the current visit. This ensures that the engine won't need to be removed early solely due to LLP expiry."

Aero Norway believes that the two most important elements of cost effective workscoping during an engine shop visit are 'know what you have' and 'what you

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want'. For example, what the condition of the engine going into the shop is: removal reason, hardware condition, commonly known hardware fallouts, remaining LLP life, applicable airworthiness directives etc. Dag Johnsen, its Chief Operating Officer, explains further: "This way you know what you have to work with and what parts you need to start sourcing, including expensive LLPs. The next factor to consider is what you want out of the engine when the engine is completed. The key is to have a pre-determined target build life relevant to hardware and LLP residual life so you don't overbuild or under-build the engine. Knowing what LLP life you are building within the modules - such as fan, core and low-pressure turbine (LPT) - provides an opportunity to look for used residual life LLPs in the market, this can save millions during a shop visit." However, he does include a codicil. "This does not necessarily apply to the entire engine. Not all modules need to reach the same build goal as you can, for example, can plan a "light" shop visit sometime in the future to swap out a major module such as an LPT."

Engine life-limited parts have a significant role in the creation of work scope. Life-limited parts (LLPs) always account for a high proportion of total engine maintenance costs on short-haul operations because of short average cycle times and the high rate of accumulation of FC, with approximately 70% of the cost of an engine shop visit is due to replacement of material. Consequently, as Oliver Boro, Engine Specialist at AMROS Global, tells us: "If life-limited parts (LLP) require replacement the material cost will increase further. LLPs should ideally be replaced when the engine is due for a high-level work scope. This way the engine needs to be in a high level of disassembly, and so the additional man-hours required to perform LLP replacement possible will be minimal." Bruce Ansell, Technical Manager Engine Division, APOC Aviation, goes into greater depth: "To maximise the life of the engine the LLPs should have an equal amount of life remaining; this ensures that they will all expire together. Although this makes for an expensive shop visit, it reduces the possibility of excessive EFC (engine flight cycles) being lost. (LLPs with less than 4k cycles remaining are difficult to justify.) Alternatively, it is possible to build an engine based on modular life i.e. different modules may have different levels of life remaining, although this can again lead to lost life if there are only a few thousand cycles remaining between the modules."

Engine life-limited parts (LLPs) define the safe operational lifespan of key components, measured in flight hours or cycles. During an overhaul, their status is critical; if many LLPs are nearing their limits, a broader overhaul with multiple part replacements becomes necessary to ensure safety and reliability, directly impacting cost and downtime. Thus, as Virgil D. Pizer, Chief Executive Officer, PEM-AIR Turbine Engine Services points out, "Smart work scoping reviews historical usage and predicts wear on LLPs. When parts are still within safe limits, maintenance can be more targeted, extending on-wing time while balancing the expense of replacements. This careful planning minimizes unplanned downtime while keeping the engine compliant with safety standards. Furthermore, integrating LLP assessments into overall maintenance strategy not only mitigates risk but also supports lifecycle planning. Advances in predictive analytics and digital tracking now enable more precise scheduling of overhauls, optimizing both cost and performance."

Of course, we shouldn't forget that there are many different engines out there with differing requirements, as we are reminded by David Blackburn, Senior Vice President Asset Leasing & Trading with PTS Aviation, a StandardAero company. "Speaking specifically about CFM56-5B and -7B engine shop visits, it is wise to match the LLP cycles remaining to the condition and performance of the engine. In other words, you do not want to spend an inordinate amount of money restoring the core blades, vanes and hot section components of a CFM56 engine when the life remaining in your LLP expires in 3,000 cycles. Conversely, you do not want to spend an inordinate amount of money purchasing new or high-cycle remaining LLP when the performance of your engine will allow you to operate only another 3,000 cycles. The plan should be to match

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Engine life-limited parts, or LLPs, provide the upper bound of possible engine usable life, commonly referred to as "green-time." The lowest limiter on the LLP is an engine's maximum amount of operation before maintenance is required. As a result: "Matching LLP life across a stack of LLPs during the material procurement process helps asset owners improve their margins, i.e., if a stack has non-uniform life remaining, there will be usable LLP life in some LLPs that is paid for but not operated because one LLP reached its usable life before the others," Andrew Storch, VP of Asset Management, Setna iO, points out. John McCarthy, Director Business Development, VAS Europe rounds off the topic nicely by pointing out that: "In an ideal world, planned shop visits for overhaul or performance restoration would be driven by engine life-limited parts reaching the end of their available cycles. Engine life-limited parts play a critical role in the shop visit and determine to a large degree the extent of engine shop visit work scope. At every engine shop visit, maintenance and repair managers must ask the question: Can we use the opportunity of this shop visit to optimise the engine life-limited parts status? If that is the case, then more detailed questions follow, such as: what is the longer-term cost of not using the opportunity to optimise the engine life-limited parts?"

Should or can you avoid removing engines due to life-limited parts?

The general consensus on this aspect is that you can't avoid removing an engine if a life-limited part needs replacing and this cannot be done with the engine still on-wing. When it comes to expired life-limited parts (LLPs), the objective isn't to avoid engine removals merely for the sake of maintenance logistics but to strategically plan them so that you're not forced into an unscheduled event. Once an LLP reaches its approved limit, it becomes a non-negotiable safety issue—continued operation is not permitted under regulatory standards. This means if an LLP expires while still on-wing, you're obligated to remove the engine to carry out the necessary replacements. According to Virgil Pizer, "The best approach is to plan engine removals in advance based on predicted LLP wear. By aligning scheduled maintenance with the expected expiration of these parts, operators reduce the risk of an unplanned, costly removal. In essence, proactive work scoping is key: it ensures that you replace LLPs before they reach their limit, thereby avoiding emergency removals while balancing costs and maximizing on-wing time. Beyond this, embracing advanced predictive maintenance tools can further refine your schedule. These systems analyse usage data and predict the remaining life of LLPs, enabling you to time your maintenance events more precisely while avoiding the pitfalls associated with expired parts."

Beyond this, David Blackburn tells us that: "Most operators have engine fleets with a mixture of high, medium and low cycles remaining in each engine's LLP stack. Operators should plan engine removals and engine shop visits accordingly to ensure that they have the necessary thrust/lift when needed, especially in order to support operations in high-utilization seasons (when airlines and cargo companies can generate the strongest revenues and profits throughout the year). Ideally an operator should attempt to match LLP cycles remaining throughout the engine stack in order to run down the majority of their LLPs to the last cycle. Discarding LLP with sub-optimal cycles remaining (which cannot

Virgil D. Pizer, Chief Executive Officer, PEM-AIR Turbine Engine Services

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be remarketed or sold) can be costly and unnecessary...and proper LLP procurement and management for each engine can maximize build efficiencies during each engine shop visit," while Andrew Storch suggests that, in theory, engine health monitoring metrics such as exhaust gas temperature (EGT) should correlate with LLP life utilisation. "When an engine is operating at higher temperatures and/or increased vibration, it is usually the case that the LLPs are reaching the ends of their usable lives. If this is not the case, the engine needs to be removed and serviced while the LLPs still have usable life. Obviously, this process costs the asset owner time and money, so efficient engine green time management involves overhauling or repairing assets to operate to the extent of the LLP limiter," he advises.

If the engine operates within its performance parameters, in the end you can't avoid removing engines when life-limited-parts expire. If you operate an engine long enough, the life-limited parts will reach their limit. We have seen this in many CFM56-5B and CFM56-7B engines through the 2010's where the engines performed flawlessly and reached their LLP limits says John McCarthy at VAS, adding that: "What you seek to avoid is having to remove an engine for just one expired life-limited-part deep in the HPC – HPT modules while there are substantial operational cycles remaining in the rest of the engine LLPs and the EGT and ECM parameters."

Dag Johnsen gives an interesting overview of the problem in his explanation of the situation – an engine has three 'lifelines': performance such as EGT margin;

Anca Mihalache, Managing Director, AERO CARE

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hardware condition such as out of limit conditions found routine inspections, and lastly LLP expiration, or (in some cases) other mandatory removal requirements. He then expands further: "Aero Norway believes the goal is to try to match all these removal drivers together as closely as possible. In other words, if you overhaul an engine to a full performance restoration level and then have to remove the engine due to LLP expiration with lots of performance life remaining, lots of the money spent on the full restoration cost will be lost. Operators in hot and harsh environments will typically see removals due to hot section inspection fallout or running out of EGT margin prior to reaching LLP life, while operators with the same engine model in a less severe environment may be able to operate the engine to the full LLP life. The goal is to closely restore the engine to the optimum level according to where and how the engine will operate next."

Ben Jacques, VP Marketing and Acquisitions, Contrail Aviation Support, together with Anca Mihalache, Oliver Boro and Bruce Ansell are all very succinct in their advice, none of which is contradictory. According to Jacques, "Engines should be removed ideally when it's most cost effective for the maintenance required, it is inevitable that sometimes that will be due to LLP expiry. The most cost-effective time is not always what was planned due findings uncovered during the shop visit!", while Mihalache suggests that: "Whenever possible it is recommended to avoid removing engines only because the LLPs are expired. Once an engine is inducted for LLP replacement, the engine must be opened. Which means that the mechanics/engineers will be able to notice issues with non-LLP parts that need to be repaired before the engine can be put back in circulation in

"Once an engine is inducted for LLP replacement, the engine must be opened. Which means that the mechanics/engineers will be able to notice issues with non-LLP parts that need to be repaired before the engine can be put back in circulation in serviceable condition."

Anca Mihalache, Managing Director, AERO CARE

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serviceable condition. Again, planning is very important to avoid just an LLP replacement shop visit." Oliver Boro is adamant that: "Installed life-limited parts shall not exceed the approved limitation as specified in ALS. When the approved limitation expires, the engine shall be removed from the aircraft for maintenance and disposal of the expired life limited parts," while, to round things off, Bruce Ansell puts it very bluntly: "No, the LLPs are life-limited for a reason, there are safety factors in play and the loss of an LLP whilst in flight could be catastrophic. We have to trust that the OEM has got their R & D work completed and verified by the regulating authorities."

What role do used serviceable LLPs play?

Used serviceable LLPs play an essential role in engine maintenance by offering cost-effective, certified replacements for new LLPs. These are components that, although previously used, have been inspected and confirmed to be within their approved service limits with complete traceable documentation. By using these parts, operators can significantly reduce overhaul expenses compared to buying brand-new parts, while still meeting stringent safety and regulatory requirements – and when properly utilized, extend the green-time of an engine. Virgil Pizer goes on to say that: "Their inclusion in an engine shop visit allows maintenance teams to align their work scopes more economically. When a shop visit involves parts nearing expiration, integrating used serviceable LLPs can optimize the balance between cost and extended on-wing time. This strategic approach not only helps manage budgets but also minimizes unexpected removals and downtime. Advances in traceability and predictive analytics further enhance the viability of using these parts, ensuring that every used LLP is rigorously tracked back to its origin. This guarantees reliability and maintains the engine's residual value, making used serviceable LLPs a cornerstone of modern, cost-effective engine maintenance strategies."

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> *Andrew Storch, VP of Asset Management, Setna iO*

David Blackburn decided that one specific area was especially important, and that was mid- to high-cycle remaining LLP, stating that: "Used serviceable mid-to-high cycle remaining LLP is vital to help minimize engine build material costs, and each build will depend on an operator's monthly and yearly utilization schedule and equipment needs. Due to the limited availability of cycle-specific time-continued LLP, engine operators, owners and MROs should strategically be in the market '100% of the time.' acquiring engines and stand-alone LLP packages in order to support and promote future cost-effective engine build solutions." Andrew Storch adds: "Serviceable LLPs almost always provide substantial cost and lead time savings, while maintaining reliability. Given that dynamic, demand for serviceable LLPs is always strong, even with a sunset aircraft or engine platform."

Used serviceable LLP's offer real savings over new. For example, a life-limited used serviceable part with say 10,000 cycles remaining on a 20,000 limit, will sell at 50% of the new price. If the engine it is being fitted to an engine expected to run for another five years, then this USM LLP should last until the engine is removed from service. As John McCarthy further explains: "Buying the same engine life-limited part new, at twice the price, and fitting it to an engine with a predicted five-year run will result in a life-limited part that has 50% of its life remaining when that engine comes out of service. As engines age and the market shifts to newer generations, the future market for this LLP with 50%

Andrew Storch, VP of Asset Management, Setna iO

Ben Jacques, VP Marketing and Acquisitions, Contrail Aviation Support

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> *Ben Jacques, VP Marketing and Acquisitions, Contrail Aviation Support*

of its cycles remaining may not be very robust. So, in this instance, the USM LLP is a very effective alternative for an engine with five years life left, in terms of both upfront purchase costs and the potential diminished residual value of a new part with cycles remaining." Anca Mihalache in the meantime makes a valid point when looking at lead times for new OEM parts and how that can affect decisions. "If the OEM still produces the LLPs, it does so with a lead-time that can be long. So, if the market has second-hand LLPs on offer, it can be a good alternative. But the next challenge is availability of LLPs on the market, and what CR (cycles remaining) the engine's owner is looking for. The price of USM (used serviceable material) LLPs might also give an advantage to the OEMs FN (factory new) LLPs as cycle pro rata might be below 100% which would allow the buyer to save money. However, if the market is very tight, used LLPs might cost even more than the new ones," she says.

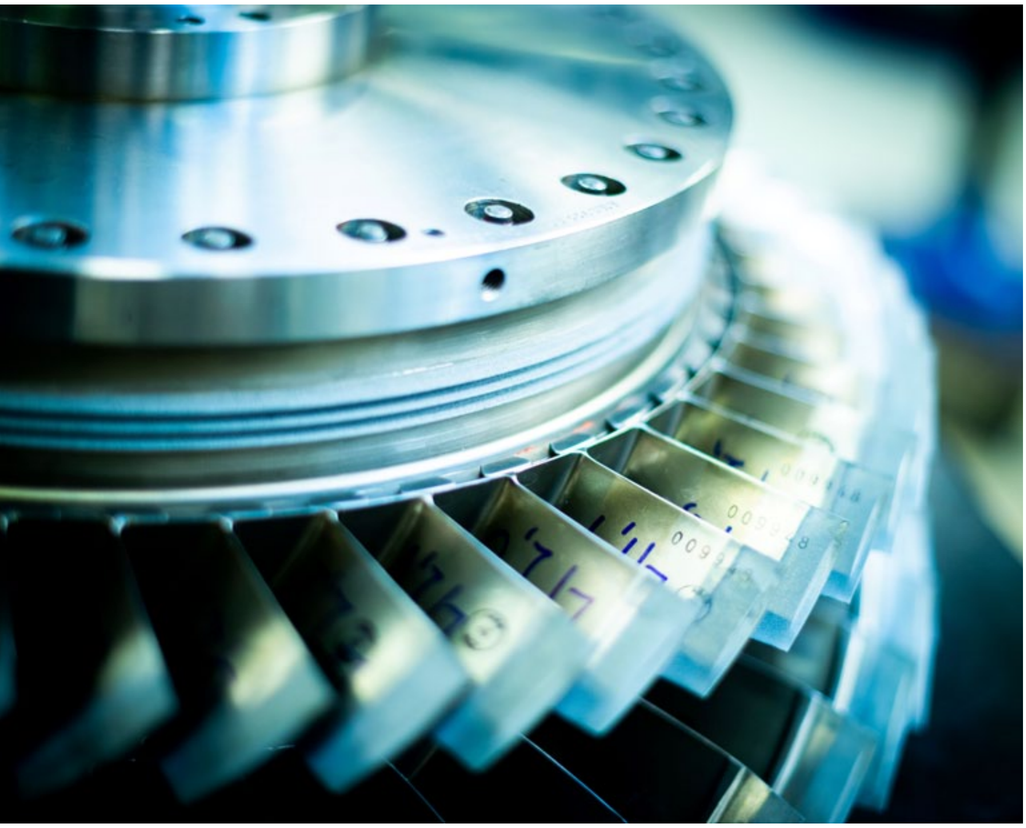
Ben Jacques is of a like mind to Anca Mihalache when it comes to the time factor. "Used serviceable LLPs play a crucial role in cost effective shop visits, to help minimise costs while maximising time on wing. When Contrail offers used serviceable LLPs it helps our customers achieve a cheaper shop visit compared, not just compared to new LLPs but sometimes against repairs. Particularly during a period of limited repair capacity it can play a key role in reducing delays," he comments, while Dag Johnson briefly states that: "Used serviceable LLPs can save money during a shop visit as the customer can find close matching residual life LLPs - to a target build, as opposed to purchasing brand new LLPs." On the other hand, Bruce Ansell tends to look more at the mature phase of an engine to assess the true merits of serviceable LLPs. "At APOC we see these playing a big part in planning an engine build in its mature phase. An engine build can use these for a limited number of cycles, either to meet end-of-lease conditions, or to maximise the remaining life of an engine. They can also be used to replace damaged parts, or parts subject to an airworthiness directive," he tells us.

To conclude this section, the use of used serviceable LLPs is a common cost-saving practice in the maintenance of mature aircraft engines, says Oliver Boro. He adds that: "Given the right material acquisition cost and the maintenance status and remaining life of the engine, this practice can generate substantial savings in engine maintenance costs. An example is the case of swapping used modules with time-continued or 'green time' modules taken from a disassembled engine."

Are there any special considerations for aging engine types?

Aging engine types introduce unique challenges that call for a more nuanced approach to maintenance planning. Over time, cumulative wear and environmental exposure can erode performance margins such as the exhaust gas temperature (EGT) margin. This means that even if an engine operates within prescribed limits, its components may show varying signs of fatigue, wear, or residual damage that aren't as apparent in newer engines, suggests Virgil Pizer at PEM-AIR. He goes on to further explain: "Therefore, LLP evaluations become even more critical for aging engines. Since these engines have already accumulated a high number of cycles and hours, there's less margin for error when assessing the remaining safe life of critical parts. Used serviceable LLPs, while cost-effective, must be scrutinised carefully to ensure they haven't been over-stressed in previous operations. Special non-destructive inspections and more frequent monitoring might be necessary to catch early signs of material degradation. Additionally, aging engines usually don't integrate as seamlessly with modern predictive maintenance tools. Operators and MRO providers often need to rely on a combination of historical data, rigorous physical inspections, and advanced analytics tailored to the engine's specific wear patterns. This blended approach helps in scheduling proactive maintenance actions that ultimately extend on-wing time and prevent unplanned removals while keeping safety and regulatory compliance in sharp focus."

With delays in deliveries of aircraft, both from Boeing and Airbus, many operators are now flying aircraft for longer than they had anticipated, leaving MROs with new, corresponding challenges. With older aircraft comes older engine types, and we were keen to see how this affected the use of LLPs. In response to the question, Ben Jacques at Contrail Aviation Support advised that: "As the industry matures, collectively we tend to find solutions for aging engine types but there are definitely engine types under pressure due to the OEMs no longer providing new parts and the current teardowns of these types not producing enough USM to support the shop visits. Given the number of module swaps performed in the last three years on the CFM56-5B and 7B and the variety of different operational histories being combined without a performance restoration of the resulting combination of modules, the next few years are likely to develop some new special considerations for that market. It's a credit to both those engine types that the extraordinary robustness of those engine variants that operators are



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so willing to work with Lessors to keep these module combinations working so well." At Aero Norway Dag Johnsen sees light at the end of the tunnel for supply chain problems relating to engine parts for mature engines. "The good news is that as fleets are staring to retire, more engines are being disassembled and this provides a steady stream of serviceable parts," he tells us.

At AERO CARE Anca Mihalache stresses the importance of planning ahead. "For older engine models, LLPs (but also other components) can be harder and slower to source. In some cases, OEMs stop producing certain parts, and availability depends on the USM market. However, the CR requirements are also lower because these engines are not so widespread. The shop visit is most likely cheaper than the newer engines and it makes sense for the engine owners to be able to build an engine with lower CR, due to a lower cost," she comments. Looking from an alternative perspective, Oliver Boro at AMROS Global suggests that: "Acquiring aging engine types can be an economic solution for airlines operating older aircraft for a few years rather than conducting full maintenance. This particularly applies to savings related to buying new life limited parts (LLPs). This can suit airlines that operate owned fleets in the last few years of their life before scrapping and retiring them."

Bruce Ansell at APOC Aviation, David Blackburn at PTS Aviation, Andrew Storch at Setna iO and John McCarthy at VAS all provided inciteful and succinct responses to the question. "Yes, availability of spares, both new and used; operators' timing requirements i.e. when will they retire the aircraft; also some MROs stop supporting some engine variants due to lack of spares support, or a reduction in market requirements," says Ansell, while Blackburn commented that: "Operators and engine owners should consider module exchanges, advanced procurement of high demand engine parts and components, and hospital-type quick engine repairs to return their engines to service in minimal time at minimal cost." Storch tells us that: "Generally, aging aircraft types and their associated power plants will be built to a lower LLP limiter to save cost and maintain fleet planning flexibility. Older twin-aisle platforms such as the PW4000 and CF6 are usually built to a much lower LLP limits, roughly half of their single-aisle counterparts like the V2500 and CFM56. This is due to both platform age and typical annual utilization," and to conclude, McCarthy advises that: "The consideration is to match the projected life of LLP with the likely service life of the engine. It is critical to avoid purchasing new engine life-limited parts close into the sunset period."

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> *Oliver Boro, Engine Specialist, AMROS Global*

What role do the leasing companies play when it comes to the build-up of an engine during shop visits?

Leasing companies play a crucial role in the process, primarily by defining the return conditions and financial parameters of the lease. They set clear maintenance standards and return condition requirements that the engine must meet at the end of each lease term. While they monitor reserve payments

Oliver Boro, Engine Specialist, AMROS Global and review maintenance records, it is ultimately the operator's responsibility to plan and execute the necessary work—such as replacing high-cost, life-limited parts—to preserve the engine's residual value. This proactive approach, supported by advances in predictive analytics and traceability, enables operators to schedule repairs in a timely, cost-effective manner while ensuring compliance with contractual requirements. Virgil Pizer suggests that: "This collaborative dynamic requires an effective partnership where the leasing company provides the framework and oversight on asset performance, while the operator manages the hands-on buildup and maintenance schedule. Advances in predictive analytics and traceability further empower the operator to optimize shop visits, ensuring that repairs and replacements are timely and that the engine remains in a lease-compliant condition. Adding an MRO service provider can add significant value in this partnership by serving as the technical and process-oriented bridge between the lessor's asset requirements and the operator's day-to-day maintenance needs. With deep technical expertise, they optimize shop visits through precise forecasting of component wear and ensure that every repair is thoroughly documented and meets both manufacturer and regulatory standards. Their involvement streamlines maintenance reserve payments, work scoping, and scheduling, ultimately reducing downtime and financial risk while supporting long-term asset performance. Pem-Air has developed these partnerships with lessors that resulted in added value to both,

John McCarthy, Director Business Development, VAS Europe

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the lessors and operators when it comes to maintenance related aspects of the relationship – and that not just for LLPs.

"Most leasing companies work closely with their lessee to optimise engine life-limited part configurations. Typically leasing companies have well-resourced, experienced powerplant teams dedicated to optimising LLP / degradation," suggests John McCarthy, adding that: "This is further supported by engine reserve fund management as the driving measurement of the effectiveness of the engine maintenance and repair programme."

Andrew Storch takes a more cautious viewpoint, advising us that: "Leasing companies want to ensure that their asset is maximally marketable upon lease return, so there may be covenants with the lessee to not install PMA parts, utilise DER overhauls, and to return the engine with a certain amount of green time remaining."

Leasing companies should independently monetise each engine asset

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and invest in and/or build each engine depending upon their forecasted return on investment (ROI) and/or EBITDA goals. Operational life remaining, along with on-wing dependability and reliability, will make a huge impact on whether or not a particular lease asset will generate the necessary revenue and profit for a leasing company, advises David Blackburn. He goes on to say that: "Short-term and long-term leasing opportunities are useful to lessors, operators and MROs alike. Having strong engines available for installation and use will ensure aircraft are flying and generating the predicted revenue for both the lessee and lessor. Lease financials and specific shop visit engine builds will be based on projected and/or required airline utilization models, as well as the benign, medium or harsh environments they operate in."

Leasing companies tend to approach engine shop visits in several different ways and the influencing factors are often whether or not they hold cash maintenance reserves and at what point during the lease the shop visit occurs alongside several other lesser factors. Leases without cash maintenance reserves are often the preserve of airlines with significantly better than average financial performance, those same airlines are often experienced and sophisticated with maintenance management, able to negotiate well with maintenance facilities, the OEMs and optimise engine build performance. In this case although lessors will have protections through the lease for engine build standards, they are often not heavily involved in shop visit work or planning. Ben Jacques goes on to advise that: "As the engine ages through its lifecycle and the likelihood of the aircraft moving out of it's lessee operation and transitions into operation with other lessees, the chance of lessor involvement in shop visit planning and build up dramatically increases. At this point the agenda of the lessor and the airline align toward squeezing every cent of value from the engine with any new investment being scrutinized for the value it brings through an increased ability to generate revenue for the lessee and lessor. Lessors in the (late) mid-life to end-of-life lease end of the market are more likely to specialise in streamlined portfolios to maximise efficiencies within their portfolios. A portfolio of 10 aircraft with the same engine type provides many opportunities to purchase LLPs, modules and parts packages, benefitting the lessor with a discount compared to individual purchase pricing. If you specialise in a small number of engine types, a lessor can benefit from end-of-life scenarios where they can harvest their own used serviceable material supporting other leased engines within their portfolio. Protecting them from market volatility and providing their lessees with an increased surety of turnaround time because there is no need to "wait for the market" or submit to overpaying because the lessee and lessor can't find optimal parts. In this period of uncertainty and volatility it remains a truism that when the interests of a lessee, their lessor and the maintenance provider are aligned, everybody wins."

Anca Mihalache makes some interesting comparisons between lease types. "There are few differences between leasing companies but there are those that prefer long term leases (most of the leasing companies) and others that prefer short term and green time leases. Long term leases require a longer time on wing so they will require high cycles remaining on the LLPs. Green time lessors are satisfied with shorter limits on the LLPs and they tend to part-out the engine once the green time is gone. On this type of engine, the lessors don't consider stacking that important," she comments. Dag Johnsen delves slightly deeper, taking onto account the relationship between the lessee and the owner/lessor, advising that: "We often find our airline customers with leased engines in a bi-party position when they send us their engines for overhaul. This itself does not pose any problems, but it can often take more time to discuss workscope escalations as both parties, operator and lessor, need to agree. Aero Norway also refurbishes engines sent to us directly from leasing companies and the process is similar to engines from operators. Lessors provide a build goal, and we collaborate on workscope levels, including locating new or used LLPs making sure we optimise the shop visit for them."

Over at APOC Aviation, Bruce Ansell raises a very valid point when it comes to the financial aspects of terms laid down by leasing companies. "Generally, at APOC we see that leasing companies set the return conditions to help with their remarketing, usually half-life or above. Sometimes an engine will be stub-leased to use up available life prior to a shop visit, or teardown. They can often request that an operator does not carry out a shop visit prior to return if the maintenance reserves held in place, plus the remaining engine value, are of higher value than an engine fresh from a shop visit might be," while to conclude matters, Oliver Boro points out that: "The leasing companies refer to the provisions of the Lease Agreement stipulated in the Maintenance of the Engine and Redelivery Condition. Conditions such as Qualifying Refurbishment, Full Engine Refurbishment, Minimum Cyclic Life (LLP), Minimum Flight Hours (HTC), Exhaust Gas Temperature Margin, compliance with all outstanding mandatory orders and directives etc. will have an effect on creating the workscope."

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