

Aviation commentators have often remarked on the increasing presence of OEMs in the engine aftermarket. This is especially the case when it comes to engine maintenance, and the declining independent MRO solutions available. OEM maintenance contracts offer maintenance stability for operators, but can the widespread adoption of these affect resale values or leasing demands? Charlotte Daniels provides an assessment.

How do total care engine maintenance contracts affect the remarketing of aircraft?

Aircraft values are driven by multiple factors, including: damage and repair history; operational location; utilisation profile; configuration; specification; and maintenance status. It has historically been mooted that using original equipment manufacturer (OEM) repairs instead of designated engineering representative (DER) repairs, will bolster an aircraft's residual values.

Aircraft's engines account for a significant percentage of value, so an operator's maintenance and management of these engines is crucial.

Globally, how many of a particular aircraft type are already on the market will affect whether the market (sale price) favours the buyer or the seller. A similar principle applies to leasing: demand will drive lease rates up, whereas a stagnating market with little requirement will cause aircraft values and lease rates to dip. It also follows that a high number of parked aircraft has a negative effect on the 'marketability' of an aircraft type.

Several factors affect demand for used aircraft, including: fuel prices; spare engine availability; lease rates; maintenance costs; OEM support; and availability of green-time engines and used serviceable material (USM). Another issue is the ability or freedom to perform maintenance without strict OEM control. It is important that the operation of maturing and ageing engines continues to make financial sense for carriers, whereas for newly-entered-into-service (EIS) engines, many operators want the comfort of transferring the risk of managing the asset to the OEM.

Early EIS engines with new technology are subject to unknown costs,

so they are exposed to potential early service issues, and unscheduled modifications arising from hospital visits. Moreover, most first-tier operators want steady and predictable maintenance costs. Those seeking to invest in new engines often require OEM maintenance support. This is why total care or power-by-the-hour (PBH) agreements have flourished.

Maintenance priorities shift throughout an aircraft and engine's operational lifecycle, as do the risks and economic strategy. For example, if engines are ageing, maintenance will focus on sourcing the most economic parts and shop visit (SV) worksopes. The operator therefore requires complete freedom to manage engine maintenance.

Mature fleets also benefit from industry experience. Most common in-fleet problems have already been ironed out, so operators feel comfortable in managing SV work scopes, removal patterns and intervals, and defects that may arise. Less emphasis is, therefore, on the OEM.

Owned vs leased aircraft

James Bennett, director of engine services at Aerfin, explains that over 40% of aircraft in operation are leased, rather than owned by airlines. The lessor, therefore, should arguably be of equal importance to the OEM, but this has not always been the case.

One might assume, for example, that a lessor would be privy to any negotiations between the lessee and OEM regarding maintenance contracts under an aircraft lease, but this is not necessarily the case. "Tri-party agreements are historically not common

in leasing arrangements," says Bennett. "The operator communicates directly with the OEM. The awareness that all parties need to be involved, however, is increasing."

"Operators are interested in keeping maintenance, repair and overhaul (MRO) costs low and predictable. How they achieve this varies greatly and depends on whether they own or lease the assets, the ownership horizon, age of the engines, and internal engineering and maintenance capabilities. These will all influence their needs in a maintenance contract," adds Leo Koppers, senior vice president for MRO programmes at MTU Maintenance. "Full-service solutions tend to be popular among start-ups and smaller operators without their own engineering departments, but also for first-tier operators flying new engine technology. We see this on current- and next-generation engines in particular."

This article investigates the problems arising from the emergence of closed, OEM-focused aftermarkets. The widespread adoption of OEM PBH and total care engine contracts has enabled manufacturers to exercise greater influence on how operators maintain engines. In addition, lessors must decide what to do with aircraft coming off prime leases at 10-15 years of age. After a second lease, when the engine is about 20 years old, lessors and owner-operators may look to gain value by parting it out and creating USM. If there is no aftermarket outside of the OEM's own network, this option is closed off, and capturing maintenance reserves and stub lease revenues is compromised. The value of an aircraft can, therefore, nosedive when a lease expires.

This causes further difficulty for lessors from the start of ownership, since it becomes difficult to put a value on aircraft at any time during their lifecycle, because values are too theoretical.

Traditionally, independent contract options have been available to operators, in addition to OEM support. The main types of maintenance agreements are outlined below. While total care is the main focus of this feature, there are other options available to operators. Total care, however, offers peace of mind.

“The trend for airline use of OEM and other aftermarket contracts came to a head in 2010-2011,” says Stuart Rubin, principal at ICF. “Value implications for engines enrolled on these programmes emerged at this point. There came the recognition that Rolls-Royce (RR) had a substantial influence on the aftermarket.”

“OEM contracts maintain higher aircraft and engine values for a time, but you reach a point where values fall off a cliff,” says Kane Ray, head analyst of commercial engines at IBA. “There comes a stage when an asset is sold into a market where it is not worth its expected value. In a closed market with a heavy OEM presence, two questions need to be asked. What is the value? How can you know the value in a controlled market?”

Many considerations need to be addressed when evaluating the impact of

total care contracts on remarketing aircraft. Is the aftermarket open or closed, or somewhere in between? How ‘locked in’ is an asset once it is enrolled on an OEM contract? If a lessee defaults on payments, how easy is it for the lessor to take over management of the aircraft before it goes to its next lessee?

Implications of a closed market need to be considered with regard to USM and other forms of repair. Will these be possible on ageing new generation engines, and if so will these remain under the proviso of the OEM? These considerations determine the shape of the aftermarket for secondary lessees, second-tier airlines, and the retirement process for ageing fleets and those being phased out. It is not simply a question of whether OEM contracts are expensive, or economic in the long term; it is about whether operators will have the flexibility to manage ageing engine worksopes, and how this will affect their willingness to take on ageing engines and aircraft, and operate them for extended periods.

“Generally, the more closed the MRO network, the more difficult remarketing becomes and the lower the residual values of the assets,” says Koppers. “Engines maintained in a closed OEM network for the first 15 years or so will have limited remarketability. This is the case on some legacy and current-generation engines,

and is likely to increase on new-generation engines.”

The term ‘total care’ tends to be associated with RR branding, but the comments in this article pertain to all engine OEM contracts in general, unless expressly advised, and the term total care will be used to describe all OEM PBH, total care and packaged maintenance and engineering (M&E) contracts.

OEM contracts

OEM maintenance contracts, which demand the use of OEM-sourced parts and repairs, ensure that OEMs have the scope to consistently put their material into the aftermarket, generating further revenues and aftermarket momentum.

OEM contracts can offer additional benefits as add-ons to the standard contract, boosting the PBH rate. One that has seen an upsurge in demand is big data analytics. “Demand for analysing big data has increased exponentially in recent years,” says Bennett. “Prognostics and risk management can also be offered as additional incentives with OEM contracts. This support can appeal to operators which naturally work towards extending on-wing times, and improving aircraft and dispatch reliabilities.”

The ‘TotalCare’ package offered by RR during engine contract negotiations

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ensures a large portion of its customers go straight to the manufacturer post-sale. Under this contract RR offers extensive aftercare support from standard maintenance through to performance restorations, repair and overhaul. Higher residual value is often suggested for engines enrolled in Total Care.

RR offers aftermarket support and maintenance agreements to Trent customers via TotalCare, SelectCare, LessorCare and Foundation Services contracts. The 'TotalCare' suite of products includes TotalCare Life, TotalCare Term and TotalCare Flex.

TotalCare Life, according to RR, provides a dollar per-engine flight hour (EFH) rate for the duration that an airline operates an engine. The agreement includes core services, such as off-wing maintenance and on-wing availability, aircraft-on-ground (AOG) support and other optional services. "Payments are also subject to commercial negotiation, and can be very favourable for the first operator of the aircraft (and therefore its installed engines)," explains Olga Razzhivina, senior ISTAT appraiser at Oriel Valuations.

TotalCare Term provides the same core services as standard, but the dollar/EFH rate only funds SVs expected to occur over a fixed calendar period.

TotalCare Flex offers the fully-reserved benefits of TotalCare Life, but focuses on mature engines, as described on the RR website. Green time management is offered to minimise costs for engines approaching retirement.

SelectCare is another RR product, offering airlines a core fixed-price overhaul (OVH) arrangement for the duration they operate the engine.

RR also offers LessorCare, a lessor-focused agreement that has recently been added to the TotalCare service portfolio. LessorCare aims to aid transition between lessees and maximise the asset value of leased engines. LessorCare customers can use off-wing maintenance and on-wing availability services when an aircraft is between operators.

As part of LessorCare's development, RR designed the Operating Lessor Engine Restoration Agreement (OPERA). This is a transferable agreement that can be called on in the event of lease expiry or default, and provides lessors with some peace of mind, yet it does normally not provide any cash return of any paid-in amounts. This remains a key issue for a lessor. "OEMs, especially RR, have worked on offering lessors a more inclusive solution to address concerns," adds Razzhivina. "This process is just starting, with only a handful of lessors signed up. It is likely to continue, as third parties rather than airlines increasingly own aircraft."

Foundation Services offers event-

based services for customers that require neither risk transfer nor long-term services contracts. The main elements are fixed-priced overhauls and time and material (T&M) SVs. Customers can also procure other service options, such as on-engine services, training or dedicated spare engine leasing, without engine overhaul.

General Electric's (GE's) portfolio of maintenance contracts is called TrueChoice. According to GE's website, this includes: TrueChoice Flight Hour, a PBH programme allowing full risk-

transfer engine maintenance; TrueChoice Overhaul, offering fixed-price agreements customised to specific engine requirements; TrueChoice Material, that offers new and used part, repair and upgrade solutions; and TrueChoice Transitions, which accommodates an engine's evolving maintenance requirements, including T&M or PBH programmes, engine and module exchanges, custom worksopes and traditional and green-time engine leases.

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Portable Maintenance for Lessors (PML) programme in 2012. PML allows lessors to control maintenance costs throughout the life of an aircraft, regardless of lessee or operator. Under PML, CFM provides MRO services for leased fleets. PML is designed to be transferable between lessees, and allows the lessor to more accurately predict maintenance costs.

According to Ray, terms range from fixed (such as 10 or 12 years), life and unfixd (such as T&M). OEM T&M agreements might not benefit from AOG or spares access, making them less attractive for operators without in-house maintenance capabilities. If the market for the engine type concerned is 'closed' it may be irrelevant whether the carrier has this in-house capability; it would have to seek support from the OEM regardless.

Independent options

Independent contract solutions offer more flexibility and can be more responsive to customer requirements. "Independent solutions demonstrate the presence of competition, and competition forces innovation," says Rubin. "This could mean lower costs for the operator, since independent MROs can decide their own labour rate. SV costs generally comprise 80% for parts and 20% for labour, as a rough order of magnitude (ROM). Of course, parts provision is determined by availability of and access to OEM parts and materials."

"Independent service providers and contract solutions offer the ability to reduce costs," adds Ray. "Such providers may also benefit from different expertise and market experience, and might be based in convenient locations. Availability of independent contract solutions offers

operators greater flexibility to be involved in maintenance management, which can be beneficial." Ray adds that caution should be exercised when implementing non-OEM designed or approved repairs. "Non-OEM repairs might negatively impact value if most of the fleet is maintained by the OEM. Meanwhile, the use of parts manufacturer approved (PMA) has largely died out, except on very mature engines."

There are smart-repair options developed separately to the OEM, which are EASA- and FAA-approved, such as MTUPlus repairs. While available on maturing, in-service fleets, it is unclear whether such solutions will be as available on all new-generation engines entering operation.

MTU Maintenance offers an independent comprehensive support solution called Total Engine Care (TEC). Koppers explains that TEC comes in the form of full-service 'one-stop' solutions that include engine maintenance, and additional services that can be combined on a modular basis, such as engine condition monitoring (ECM), on-wing/site services, line replaceable unit (LRU) management and spare engine support, among other things.

MTU's independent contract portfolio includes its Portable Maintenance Service. "The programme provides complete MRO flexibility, portability regarding maintenance (reducing 'doubled-up' maintenance efforts), and in turn, predictable and reduced operating costs for lessees," adds Koppers. "Maintenance reserves remain with the lessor during the term of coverage, are carried forward and are only drawn on during a scheduled engine SV. The lessor remains in control of the maintenance reserves all times.

Some 777-300ER retirements have been announced earlier than expected. It is possible that the onset of new generation aircraft and engines are prompting this shift.

"Furthermore, engines can be phased in and out of the programme at any point in the lifecycle, supported by MTU," continues Koppers. "MTU programme coverage also includes corrective action required by findings during an end-of-lease check, something that is not always guaranteed by other parties."

Considerations

Engines are removed and maintained according to a pattern of operation that will vary from fleet to fleet. "Engines on longer sectors have lower rates of engine flight cycle (EFC) utilisation," says Phil Seymour, president and chief executive officer (CEO) of IBA. This will affect the frequency of performance restorations and overhauls. Another issue is that the next lessee will have a different pattern of operation and rate of utilisation, so some bridging maintenance may be needed on the engines, which could incur costs for the lessors.

While this may seem obvious, the number of engines on an aircraft will also impact longevity in the market, on a fleet-wide level rather than on an individual basis. If operators have to buy in to maintenance agreements with OEMs, it follows that paying for four engines will be less attractive than paying for two.

Total care has caused some issues for lessors. Operators have encountered problems as engines age, and they need more flexible ways to optimise maintenance management. "Maintenance costs are primarily driven by materials that can account for 80% of SV costs," says Rubin. "The cost of maintaining engines is heavily stacked towards the second decade of an engine's life with an increasing level of replacement or repair required as parts wear out, and average removal intervals between SVs shorten.

"Evolving OEM or independent MRO contracts that permit use of USM and operator-defined overhaul build standards, can be more suitable from an economic perspective," Rubin continues. "Generally, a PBH contract becomes more expensive as engines age, given the higher costs of repairing and overhauling maturing engines. PBH contracts can have a pronounced and potentially detrimental effect on investors needing the flexibility to do what they want with engines to combat residual value concerns and maximise market opportunities."

A further issue is that different OEM

contracts can have different dynamics. RR is generally acknowledged as the first OEM to introduce the flight hour agreement (FHA) and engine maintenance contract (EMC) concept via its suite of contracts listed earlier. RR is also widely seen as the most rigid and inflexible in terms, which has caused issues for lessors and operators. RR's LessorCare, including Flex Terms and OPERA products, however, have been recent efforts to overcome this.

GE, meanwhile, has allowed USM to be incorporated in its PBH agreements. Ray explains that USM has been used as early as the first SV for some engines. "This has allowed operators enrolled on GE PBH contracts to make savings early on." Nevertheless, enrolment on OEM contracts requires use of OEM-authorized shops, so control is still maintained. "OEMs tend to advertise flexibility, since their contracts include services, such as engine health monitoring (EHM) and other specialist tools," Ray adds. "While these services show more options for operators and more investment in the maintenance management of engines, is it necessarily exercising greater flexibility?"

When evaluating the effect of total care contracts on the aftermarket, Ray advises considering how many lease transitions or sales have been achieved versus how many aircraft are parked. "If

you consider 10-12 years as a standard term for the first lease, you need to anticipate how the operator is going to manage the second, shorter lease, assuming the aircraft will have 25 years of operational life," he adds. "Will the second lessee have to buy into an OEM contract to ensure maintenance is adequately managed, or will it be able to manage this independently via non-OEM MROs and a healthy supply of USM?"

Legacy programmes have enjoyed a more open aftermarket, allowing for multiple leases and secondary operational lives, such as ageing aircraft being converted to freighters. Legacy engines can also be used to garner further income via module, USM or teardown markets. The potential to manage ageing maintenance so closely has also led to the continued attractiveness of legacy engines for second-tier and low-cost operators.

It is the maturing fleet of engines that is raising questions. Ray says that there are fewer exchanges and trades than expected, when compared to historic legacy aircraft transactions on the Airbus A330 and 777-200ER fleets. Uncertainty, resulting from different factors is delaying the development of a buoyant secondary market for these aircraft. Meanwhile, new-generation engine fleets are simply too early on in their operational lifecycles for the long-term impacts to be seen.

Narrowbody & widebody

Seymour at IBA comments that the narrowbody engine aftermarket is perceived as relatively open in terms of MRO option and competition, as opposed to the widebody aftermarket. There are more narrowbody operators, so more engines are required, and there is more room for OEMs and independents to co-exist in that aftermarket.

Ray notes that the RR Trent XWB has five MRO shops, all with OEM interests: OEM wholly-owned, joint venture (JV) or part of the OEM network. The Trent 1000 has three shops.

Meanwhile, the GENx-1B has six OEM-oriented MRO shops, and the -2B has five. Ray points out that GE has more wholly-owned shops involved in GENx MRO than RR currently is for the XWB.

In contrast, the CFM56 family has 33 shops in its global MRO network. Eight are OEM-owned; five form part of an official network; one is a JV; 18 are independent shops; and one is a materials supplier. The core difference between markets is notable and the CFM56 family clearly has a reputation for longevity, reliability and a healthy market.

New-generation narrowbody engines, however, may close the gap between an open and closed market. "Availability of FHAs for narrowbody engines is a

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relatively new phenomenon,” explains Razzhivina. “Since there are significantly larger numbers of engines and higher cycle utilisation of the narrowbody engine, OEMs have had little problem with cashflow from replacement parts. FHAs were originally introduced for widebody engines because these require fewer overhauls and fewer parts throughout their lives. FHAs therefore provided cashflow for these OEMs.”

Rubin expects growth in Pratt & Whitney PW1000G and CFM LEAP engines on OEM PBH contracts due to new technology. “Given the volume of narrowbody engines that will be in the aftermarket, however, I doubt that OEMs will be able to keep the entire aftermarket locked up 10 years after EIS of these engines,” he counters. “OEMs are likely to give more contracts to independent MRO shops to meet SV demands as new-generation engine types mature. The narrowbody market therefore offers the biggest opportunity for MROs.”

Rubin also considers it possible that, due to the expected increased performance of new generation widebody engines, a second SV might not be needed for the next wave of widebody engines.

Maintenance management

Bennett explains that the Total Care concept was first introduced by RR supporting the Trent-powered American Airlines fleet. “This was nearly 20 years ago, and was designed to provide cost predictability for operators, which is critical during the first 10-12 years of operation,” he adds.

“Operators want flexibility as their asset ages, such as more control over the build specification and worksopes,” says

Rubin. “OEM maintenance contracts restrict this. Operators want to control the type of parts going into the engine during an SV. They do not want an engine ‘gold-plated’ forever. Maintenance can be more economic if the OEM does not have a stronghold on the aftermarket.”

As a general rule, engines make up 25-40% of the aircraft’s value in the early stages of EIS and operation. After 12-15 years, the proportion can be as high as 90%. The engines are value-critical by this stage, so operators seek to economise. As will be explored, by this stage, and likely during the second lease for the aircraft, most operators have opted out of Total Care. Aircraft that are enrolled in long-term total care contracts run the risk of not aligning adequately with the needs of the second lessee.

A further problem may be that the primary lessee defaults, or a lease terminates midway between SVs. Transferring or adapting to a new operator’s utilisation and requirements, or allowing the lessor temporary control over maintenance management, can be complex - or even impossible.

PBH is, therefore, most attractive for the first lessee or operator. For older engines more industry know-how is available, more USM, and lower build standards can be used. This shift can happen at around the 10-year mark, which often coincides with the end of first lease term.

“As engines start to mature, MRO costs increase due to a need for heavier SVs and material replacement,” explains Koppers. “The CFM56, V2500, CF34 and GE90 engine families are all extremely interesting in this regard. Over the next five years, many of these engines

will start to mature, and this is when operators are likely to centre their maintenance efforts on cost-reduction and become more interested in other contract forms and alternative solutions.

On EIS, engines comprise 25-40% of the total asset value. This can rise to 90% over its lifetime. Buy-in costs are a significant consideration for secondary buyers, and are affected by the number of engines and airframe has.

will start to mature, and this is when operators are likely to centre their maintenance efforts on cost-reduction and become more interested in other contract forms and alternative solutions.

“Mature engine programmes focus on reducing costs for operators of ageing engines through cost-effective MRO alternatives (such as smart repairs, used parts, or customised SV builds) and alternatives to MRO (including instant power solutions, such as engine lease, sale and exchange),” adds Koppers.

For customers with younger, current-technology engines (for example, the V2500 and CFM56-5/-7), Koppers adds that the focus is on longer-term and cost-effective operations with increased on-wing times as a way of reducing costs. “This can be achieved through services, such as optimised fleet management to ensure the optimal and most cost-effective removal time,” he says, “This can be through customised worksoping, alternative repairs or engine trend monitoring, for example.”

LLPs

One aspect of ageing engine maintenance that needs considerable focus is management of life limited parts (LLPs). LLPs will often not need to be replaced for thousands of cycles, often up to 25,000-30,000EFC in modern engine types in the case of some low pressure (LP) parts. While this is the case for many in-service engines, operational experience of which has allowed the OEM to extend the life limits of these parts, it is often not the case for new-generation engines. The youthfulness of these engine families, combined with new design technology, has meant that some life limits set upon engine EIS remain relatively low (see *Early operational performance of Trent 1000, Trent XWB and GEnx engines, page XX, this issue*). Razzhivina explains that LLP replacement can be costly as part prices are controlled by the OEMs. These typically escalate by 4-7% a year.

LLPs are not usually part of a PBH or total care agreement. This means another element of maintenance requiring cash reserves if leased to a new lessee. Clearly, if an operator wholly owns the aircraft, they are at liberty to decide whether EFC reserves are to be set aside for LLPs, and the dynamic is different. Given the current low chapter 5 life limits of new-



generation engines, LLP management will also be of importance to prospective buyers of maturing engines. They will expect cash reserves to be set aside for management of these LLPs if and when they need replacement.

“Sometimes LLP replacement does not become a topic before the second or third engine SV, so for first-tier engines it might not always make sense to have these covered in the first years of engine service life,” says Koppers. “For owners with a longer ownership it makes sense to make provisions earlier to keep costs predictable.” Razzhivina adds, “For operators of widebody engines on long and ultra-long routes, LLP replacement may seem an unnecessary expense. Many such engines are likely to be retired without a single LLP change.”

“LLP replacement is the major cost driver in MRO, so an operator with a T&M contract for instance, will need to plan for the cost of the LLPs during a heavy SV. Although the exchange of LLPs is not avoidable, there are alternatives available to keep costs down: USM, cost-effective repairs, or in some cases even green-time leasing,” continues Koppers. It must be considered that if a Total Care contract includes LLP reserves, it is likely that new materials will be used. It remains to be seen whether this will be the case for new-generation engines.

Koppers adds that most operators with ageing engines will switch from an exclusive fly-by-hour (OEM) contract to a non-exclusive T&M or fixed-price contract that may include these alternatives. This will arguably be the same for new-generation engines, although with a further closed OEM-controlled aftermarket, will there be the flexibility to source economic solutions

independently? Ultimately, will these alternatives be available for next-generation engines as they mature?

“Widebody engine LLPs are generally not included in the OEM agreement,” Seymour adds. “Operators should consider if cash reserves are going to be needed for future LLP replacement. Primary lessees often will not prioritise this, since it is unlikely to be a big issue during the 10-12 years of their lease. New generation LLP lives are sometimes low initially, but the industry expects these to increase as the fleet matures.”

“LLP replacement is an increasingly important aspect of mature engine maintenance but this is time-based and costs are well known and easy to factor,” says Rubin. “LLPs are rarely factored into most two SV/12-year contracts for widebody aircraft. OEM PBH agreements are based on EFH, so converting the fee to cover LLP replacement driven by EFC is a challenge. The main issue with mature engines is the inability to repair certain parts, which have to be replaced with new or refurbished ones.”

Rubin explains that initial calculations for those paying LLP cash reserves within a total care agreement are based on lower life limits, estimated by engine EIS. It may also be observed that lessees could be paying too much in LLP reserves if it is part of a total care agreement. FHAs or EMCs with LLP cover included are rare. Normally, the lessee would pay the lessor a cash reserve based on a calculated rate for the suite escalated at an agreed percentage over time or make a cash payment at the lease exit for the life used calculated on the OEM LLP catalogue price less an agreed percentage for the stub life, usually 10%. The lessee would in that case pay for the

PBH contracts generally become more expensive as an aircraft ages. The hourly rate is therefore likely to rise by the second lease. The secondary lessee will often look to move onto more flexible contract terms, lighter coverage or T&M.

LLPs at the shop visit.

“LLP stacks really need to be factored early on in an engine life cycle,” says Ray. “These can affect the maintenance management of an ageing engine fleet, and will be a consideration of secondary and tertiary lessees. A new lessee, for example, will not want the cost of a full LLP shipset to manage from scratch.

“How LLPs are managed affects their demand and availability for later leases, which is important to lessors. The CF6 and PW4000 are prime examples of ageing fleets that still have healthy demand for used LLPs,” continues Ray. “These mature engines are still going through the shop, because robust USM and green-time markets exist. There remains a small number of surplus or parked engines, which is crucial for residual values.”

A number of airlines, for example, are seeking LLPs for 20-25 year CF6 fleets, proving that these engines have remained cost-effective. Flexibility for managing these engines in later life has enabled and optimised demand. Ray emphasises the importance of realising that a closed market will not permit engines to be managed effectively. The large uptake in freighter conversions also boosts residual values for ageing engines, and encourages greater parts production rates for OEMs.

“If LLP reserves are factored into Total Care contracts, the operator is agreeing to buy new LLPs rather than source USM,” adds Bennett. “If it is a primary lease and LLPs are not factored in, then the lessor will expect cash reserves to be paid to them by the lessee. A primary lease may not have to replace LLPs in the first 10-12 years, depending on utilisation.”

The difficulty, of course, is that many engines and fleets that are almost 100% (and in certain cases 100%) enrolled on Total Care are still in their first lease. It is difficult to know how flexible the market will be once they reach secondary leases. “The A330’s Trent 700 is a prime example of how OEMs may realise the need for more flexibility once SV activity starts to increase,” explains Bennett. The fleet has been in operation for over 20 years, and a large percentage is approaching or undergoing SVs. Based in Abu Dhabi, TS&S (Turbine Services & Solutions) Aerospace has become the first independent MRO to perform a third-party overhaul of a Trent 700, for SriLankan Airlines in late 2016. “This

nod to flexibility has now been given, although it has taken several years to get to this stage,” explains Bennett. “OEMs may start to open the market on new-generation engines once the global fleet is approaching overhaul and other major SV events to support the strain on the market and their own resources. That said, OEMs like RR are trying to retain this ongoing business, exemplified by the RR TotalCare Flex product, which targets operators that acquire older aircraft under a cost-per-hour programme.”

“OEMs focus on selling and providing replacement parts rather than any of the alternatives offered by other players,” says Koppers. “Operators need to look at what the bottom line is, their fleet plans (how long the engine will remain in operation) and exit strategies to decide which option to consider.”

“It is in the OEMs’ interest to open such mature markets to third-party MROs,” says Razzhivina. “This is because their own FHA commitments may become too costly towards the end of engine programmes.”

Perspectives

The key attraction of OEM contracts is the favourable effect of total care on engine residual values, at least initially. Given the percentage value that engines

carry across the aircraft, maintaining value for as long as possible is attractive for lessors investing in the aircraft. “Ensuring that new, OEM-sourced material is used in SVs during the first seven to 10 years of an aircraft’s operating life will positively affect its value,” says Bennett. “The importance of this starts to wane as an aircraft ages, and secondary operators will want assurance that they can source USM, green-time engines, or other specialist repairs more cheaply than the OEM, particularly where a Total Care solution could be cost-prohibitive.” While an asset on an OEM contract offers buyers a clear and reassuring maintenance history, it is at this later stage that the bolstered residual value may take a knock.

Operator & lessee

An operator of a new type of engine, the primary lessee, will have a different outlook and priority to a secondary lessee or the owner of an ageing engine. Take the example of a newly EIS engine. As has been established (*see Acquiring maintenance capability for new generation engines, Aircraft Commerce, February/March 2015, page 34*), these can be subject to early operational issues, performance upgrades, unscheduled SVs and hospital visits. There are two main

perspectives to consider when weighing the effect of total care contracts on remarketing an asset: that of the asset operator (or lessee), and that of the owner (lessor). “Operators will discuss maintenance contracts directly with the OEM early on in negotiations, when considering acquiring a new aircraft type. This will include several engine related negotiations such as installed engine price, spare engine price and the associated maintenance contract,” explains Seymour. “At this stage, it is not a tri-party agreement that involves the lessor, so several factors can blur the costs and structures of these Total Care contracts, including the number of engines the operator wants to buy, their airframe and engine credits, and whether spares and other add-ons might be agreed early on that skew the PBH amount. The amount paid for each EFH for Total Care is not always clear or transferable.” “Total Care can be complex,” adds Bennett. “For example, an airline’s own operating profile can change dramatically. If it decided to become a low-cost carrier overnight, the change in utilisation patterns would affect maintenance management.”

“Total care has the general advantage of risk transfer for the operator, since it covers unscheduled maintenance,” adds Seymour. “The use of Total Care aligns

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the interests and aims of the OEM and the operator, which are to maximise on-wing time and minimise spares on the ground. Meanwhile, the operator takes advantage of access to the best available materials and assured SV availability.”

“FHAs were originally designed to attract airlines, since they used to be the main buyers of new aircraft,” explains Razzhivina. “Airlines appreciate the cost certainty for the duration of the contract that FHAs offer.”

Operators enrolled on Total Care contracts must have other considerations. “Reality has crept in over recent years,” continues Seymour. “While there is very little disadvantage for the operator of a new/maturing engine that is on total care, it is become more difficult to economise by investing in USM. Essentially you are paying maintenance reserves to an OEM, which are accumulating with them rather than gathering interest.”

“The other potential disadvantage is that, particularly for a closed market, if demand for certain components is high, operators are not necessarily guaranteed immediate access to those components,” says Ray. “Since all demand has to go via the OEM, in periods of high or intense activity this can have a negative impact on SV turnaround times (TAT), and even engine stand availability.”

The lessor

Koppers says that full-service, all-inclusive support contracts, offered by OEMs at the point of sale, bind lessors to them for a fixed period. “Lessors and owners are often looking at the longer term, because they may intend to own the asset past the first operator,” says Razzhivina. “Their concern is to have

sufficient cover throughout an engine’s life, including replacement of parts (or even the engine) in the EIS stages, as well as maintenance costs later.”

Traditional total care agreements have been reached between an OEM and a lessee. Tripartite negotiations have been rare, and the lessor is not involved in the maintenance management of owned engines, which can pose a problem. What has become more problematic is the lessor’s lack of involvement in receiving the maintenance reserves. While these were traditionally passed from lessee to lessor for SV events, the typical Total Care agreement involved lessees paying these straight to the OEM, bypassing the lessor. Maintenance reserves are calculated on the individual basis of operating pattern and rate of utilisation. The payment arrangement may not be a problem during a standard fixed-term contract, unless things start to go wrong.

“Ideally, for the lessor, it wants to accrue cash for future SVs that the operator can draw down as and when the shop visit occurs. In the Total Care arrangement the payments made by the operator to the OEM for the SVs makes it risky for the lessor in a variety of ways,” says Seymour. “Essentially they cannot access any of the cash being accrued or invested in the maintenance of their asset. The airline or lessee could go bankrupt overnight, for example, leaving the lessor with no financial security for the future shop visits.”

The operator perceives the added value that total care provides, while there is little benefit for the lessor. “OEMs are making efforts to become more flexible in response to the needs of the lessor,” continues Seymour. “RR’s OPERA and LessorCare initiatives are two recent

The CFM56 engine still has demand for USM and used LLPs, which is extending the life of its global fleet. Appropriate LLP management is important for lessors in order to maximise the demand of a maturing fleet and asset.

examples. Payments can be called upon if the lessor is suddenly exposed. The bottom line is that the lessor needs to see more cash for Total Care to work both ways.” Such initiatives are recent:

LessorCare was announced this year in response to growing concerns arising from the problems remarketing aircraft (see *Post Lease and Remarketing* section).

“Lack of control of SV workscopes has also posed a problem for lessors,” says Rubin. “In addition, maintenance contracts agreed between operators and OEMs are usually applied as a fleet agreement for the operator, so it is difficult to calculate costs applicable to a single asset. This can create confusion for the lessor if the lessee defaults.”

“A lessor’s own powerplant department is no longer intrinsically involved in the maintenance management of many engines enrolled in TotalCare, especially if they are not privy to the discussions between the lessee and the OEM,” adds Bennett. “It is also worth noting that many airlines, whether they lease or wholly own the engines they are operating, have the capacity to manage maintenance of the engines in house, rather than pay the premium to the OEM.” Given the new technology featured in emerging new generation engines that have EIS, longer time on wing (TOW) and time between SVs is expected. It is conceivable that, despite a carrier paying a TotalCare premium to the OEM for a 10-year fixed term an SV might not even occur. If the contract expires, and the lessee returns the aircraft to the lessor, one could ask why have they been paying reserves to the OEM.

“Lessors also need to ascertain whether the TotalCare agreement is consistent with the term of the lease,” says Ray. “What happens if the lease is extended? Will the operator choose to extend its enrolment on TotalCare? If the operator’s lease ends, what will be the buy-in fee to keep the engines on TotalCare? Additional discussions need to be had to avoid issues during an aircraft transition, beyond whether the lessor can access the maintenance reserves.”

“OEMs are adapting and marketing such packages to lessors now,” adds Koppers. “Perhaps most crucially from a lessor’s perspective, these deals change the nature of maintenance fees. Fees are no longer a way of building up reserves for later maintenance; they are an insurance

fee for on-going usage (term-based rates) held by the OEM. The OEM can now give credits for future maintenance work, but also hold the money, which is at least a compromise for the lessor.”

“OEMs are working on making cash reserves more available to the lessor and making efforts to address their concerns,” says Bennett. “Another example is the portable maintenance for lessors (PML). PML offers portability to lessors, as long as the lessor continues to use a CFM International MRO facility. CFM, therefore, ensures that aftermarket business is retained.” An additional example is RR LessorCare, which offers a comprehensive choice of specific services for RR engine types. LessorCare includes OPERA and allows lessors to essentially ‘fill the shoes’ of a defaulted lessee.

“The newer ‘insurance’ fee structure not only binds the lessor to the OEM in the case of the lessee being in default, it usually obligates lessees to send engines to an OEM shop to perform the work,” agrees Koppers. “The lessee will enter into a separate agreement with the OEM, which can take the form of different contract types, according to the operator’s preference. What they cannot choose, however, is their provider and most often, the type of maintenance and workscope the engine receives.” It seems that while OEMs are beginning to

respond to the feedback that has emerged from the use of Total Care, they remain reluctant to allow support networks to broaden. “Lessors have been excluded from FHAs and sometimes had little detail of the actual payments and terms prior to purchase/leaseback,” summarises Razzhivina. “Some lessors have found that term FHAs, although favourable to the first operator, may be less favourable to those who own and operate it past the original FHA term. The dissatisfaction arising from such situations has caused the OEMs to start re-thinking the role of lessors and other third-party owners in the FHAs.”

Post-lease & remarketing

Essentially, the biggest issue posed by TotalCare contracts has been lack of access to cash and maintenance reserves. This is not just in case of lessee default. If an aircraft is returned to the lessor, other problems can arise if the engines have not yet undergone a SV. Engines are lasting longer between SVs and mean time between removals (MTBRs) is increasing. There is no guarantee that a 10-12-year-old engine been overhauled by its second lease, or by expiry of a fixed-term total care or PBH contract.

This means that a new lessee may face the cost of an expensive overhaul with no

access to maintenance reserves paid to the OEM by the previous lessee. One option would be for the new lessee to ‘buy in’ to the TotalCare contract. By this stage, the aircraft is older, has accumulated more hours, and the OEM is not as incentivised to be competitive with secondary engines.

Buy-in fees can be exorbitant, and in many cases uneconomic. Since the operator is likely to try to find cost-effective solutions to the engine’s maintenance management by this stage, it may make sense to go forward on a T&M or more flexible maintenance programme, but this does not prevent the inevitable cost of that overhaul SV. Total care has at times made remarketing of such aircraft difficult.

This can be addressed if lease-return conditions set between the lessor and primary lessee stipulate that engines undergo an SV before lease expiry. This only works if the lessee does not default before the lease expires.

“The remarketability of an aircraft or engine is highly dependent on the secondary market,” explains Koppers. “Where competition is permitted and is healthy in the aftermarket, the residual values of engines and piece parts remain strong because there is interest in trading used engines. On engine types where this is not the case, the opposite is occurring.

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the perception of ‘OEM is better’ and how it impacts asset value and remarketing efforts,” continues Koppers. “This perception has increased demand for maintenance with OEM parts and approved repairs, even though there are alternative repair processes. It suggests that assets maintained to OEM standards will have better value when remarketed, but if the market is limited or non-existent, the use of OEM or non-OEM processes and repairs is irrelevant. Even on a secondary market, you need a buyer to pay more for an OEM-maintained engine to recoup added costs.”

OEM full-service contracts work on the basis of term-based maintenance fees. “This raises the question of what happens towards the end of the lifecycle, when maintenance becomes more costly due to the need for replacement parts, such as LLPs. The engine could turn out to be under-reserved and the lessor has additional outlay,” observes Koppers.

The dynamics of an engine under a total care programme run well. Problems appear when an aircraft and its engines need to find a new lessee. “This depends on how easy it is to transfer an existing maintenance agreement, which can vary between OEMs and contracts,” says Rubin. “Some contracts have restrictive covenants. A lessor needs control over the agreement and default clauses to determine the complexity of transferring these agreements.”

Access to cash maintenance reserves tends to make such a process easier. “If an asset is going from a tier-one to a tier-two operator, the new lessee will request the asset comes fresh from an SV so that maintenance is effectively ‘zeroed’. Lease-return conditions will likely stipulate this if the engine is on total care,” continues

Rubin. “This, however, does not negate the difficulty of ‘buying in’ to a new contract as the secondary lessee.”

Examples have been cited by sources, such as a GE90-powered 777 leased to an Asia Pacific carrier. The airline put \$20 million upfront as a letter of credit, which was supposed to be enough to cover engine maintenance during the lease term. The airline, without communicating this to the lessor, signed a flat rate engine maintenance agreement with GE.

The airline then advised the lessor that it did not want to renew the letter of credit - but the lessor disagreed. The airline ended up paying two sets of reserves, one to GE and one to the lessor.

Seymour explains that lessors have on occasion set lease-return conditions that have not been met by the lessee. It is a common requirement for engines to undergo major SVs, for example, before being handed back. Airlines, however, must ensure that return conditions are understood and agreed by the OEM to prevent unnecessary shop visits that may not have been originally foreseen. “Also, not all lease return conditions between the lessor and the lessee set freshly overhauled engines as a term. It typically depends on the length of lease, utilisation, and the liquidity of the operator leasing the aircraft. This means whether the lessee in question can realistically afford a high-cost SV at the end of the lease period,” explains Bennett. “This has historically posed a problem when the lessor takes back engines that are at a mid-point between SVs, without realising that it cannot access the maintenance reserves paid to the OEM for the future SV. This has posed significant problems for the lessor when trying to sell or re-lease the asset. The OEM has collected

Mature engine fleets, such as the CF6, benefit from long-held industry experience. Most fleet-wide problems have been established; therefore operators are more comfortable managing SVs and general maintenance in-house.

reserves for half the removal interval, and keeps them, and meanwhile the lessor has no reserves for engine maintenance, and an SV will have to be paid for. This leaves the lessor with an aircraft that has an engine or engines in half-life condition and no reserves in hand, making it difficult to remarket and without the money to bring the engines back to the desired standard.

“A new buyer or lessee will want to negotiate to account for the proximity to a major SV, and could face a further problem if the maintenance agreement has expired or cannot be transferred. They then have to pay a buy-in fee to re-enter the agreement,” Bennet continues.

Of course, it has been established that ageing engines are easier to make economic via USM and other methods, so one might ask whether a second lessee will want to enrol or buy in to another TotalCare contract. The difficulty is, however, that the current shape of the aftermarket suggests that there will at some point be a wave of enrolled engines coming off a fixed-term lease, with few alternatives available to lessees.

While the operators of modern engines have typically sought to progress onto more flexibly-termed total care contracts, or T&M arrangements from the secondary lease onwards, the question arising now is what options the secondary lessees of the new generation of engines enrolled in total care will have. Koppers explains that the shift away from OEM engine contracts tends to start around the time of the first LLP replacement SV. “For widebody engines, this is when we tend to see the first operator transition, and for narrowbodies this tends to signify the end of the initial PBH agreement terms,” he says.

“The second lessee invariably is taking on older engines, which have already been operated for about 10 years. This implies higher risk for the OEM if enrolling these in a total care contract,” says Seymour. “This means a higher PBH fee for the secondary lessee if they enrol on a similarly structured agreement.” Rubin adds that the lack of competition in an OEM-dominated aftermarket becomes more of a problem for second-tier lessees, wanting more flexibility in their maintenance management.

“Lessors have not been involved enough in the workscope planning and management of assets under Total Care



The recent Trent 700 SV, undertaken by TS&S Aerospace, has led many to examine whether the engines market is beginning to open for independent providers.

to date,” says Bennett. “Ascertaining the true impact on marketability has therefore been difficult. The dynamics change depending on whether the aircraft and engines are legacy, modern or new-generation. This means that age is a factor, and some engine types and fleets are more OEM-controlled than others. For those engines whereby most or all of the fleet have been enrolled in Total Care contracts, it is simply too early to make a definite view on the true effect on marketability. All that is certain is that the portability of the contract, access to maintenance reserves, and the necessity to incorporate USM as the engine matures remain the key influencing factors. And these vary from fleet to fleet.”

“The market is now shaped so that it is too complex to manage engines not under maintenance contracts for operators, particularly for widebody new-generation engines,” says Seymour. “If an operator was not enrolled into total care and had to buy in to the contract, costs would exceed the total care premium. Operators have to pay a significant fee to secure the risk transfer back to the OEM, especially if the engine has not previously been enrolled in total care.

“Say an A380 had a buy-in per engine of \$3 million for a new lessee, this would equate to a \$12 million buy-in fee for the four engines,” adds Seymour. “It is economically unviable. Because operators of new-generation engines have very little choice in non-OEM independent MROs, those that choose not to secure total care for any new-generation engine type, regardless of the OEM, will be at the back of the queue for SV time and space. If OEM shops are full, bidding and overtime rates also apply.”

Retiring fleets

There have been examples in recent years, where the use of an OEM contract has altered the retirement process of some fleets. This has led OEMs to review their maintenance contract portfolios, meaning that some flexibility has been introduced that was not present during these retirements. It therefore remains to be seen whether the same will apply to future retirements. The A340-600, for example, was affected by the total-care-enrolled Trent 500 fleet. Due to costly fuel burn and high maintenance costs, there was no secondary market for aircraft, which led to part-outs and a surplus of spare engines. All this severely impeded values. “More than 30% of the A340 fleet is parked,” says Ray. “The engines are unsold.”

“Typically deals were agreed between airlines and RR on 10-year Total Care agreements for the A340,” adds Seymour. “Upon their expiry, all Trent 500 engines were serviceable, and on the surface marketable: they were midlife engines with time before the next SV. The next operators, however, wanted access to half the maintenance reserves, but the fixed-term contract had expired between the primary lessee and RR which meant no cash reserves could be accessed.” In Ray’s opinion, GE90-100 engines may be the next fleet facing a similar challenge.

Rubin of ICF says the 777-200ER faces a similar issue. “Values in the fleet declined in 2015, because owners could not extract the value out of the engines,” he says. “Several factors drive retirement decisions which tend to happen at the end of the second or third lease. Operators start to consider where the aircraft is in

terms of the global fleet. For instance, is there plenty of USM, and how many spare engines are there? A high percentage of parked aircraft are not generating revenues. This gives the operator leverage when looking to extend or re-negotiate its lease terms.”

“It is not just aircraft age that is affecting retirements today,” adds Ray. “The 777-300ER is one example. Most of this fleet was delivered 10-12 years ago, and the programme is now 13 years old. While the global fleet is still relatively young (and well short of the typical aircraft lifecycle of 20-plus years) retirements are still being suggested by operators.” One such example is Emirates, which announced the retirement of one of its 777-300ER fleet in late 2015. “New-generation engine programmes could be lowering the age at which aircraft and engine values start to decline,” continues Ray. “For example, the future EIS of the 777X promises lower operating costs and fuel burn. There may therefore be a shift towards new technology that could affect the usage and lifecycle of modern engines.”

Bennett cites the 737NG fleet as an example when looking at fleet retirement. Equipped with the CFM56-7B, the oldest in the fleet is in its 20th year of operation. “We have seen -7B engines reach 25,000EFH without undergoing a major SV,” he highlights. “I wonder whether many 737NG aircraft will reach a second SV due to the engine’s performance. Will operators instead agree a buy-back to the OEM and progress onto the 737MAX?” About 25% of 737NGs operated are under GE solutions.

“There have not been enough cases of such a lack of re-marketability for the impact on retirements to be determined,” considers Razzhivina. “Most of the examples cited in publications, like the 777-200ER, could just as well be due to the lack of popularity of the underlying aircraft platform. The remarketing would have been difficult regardless of the engine platform and OEM control.”

Learning lessons

“OEMs have recognised the need to adhere to lessor requirements for transportability of engine programmes,” says Rubin. “The introduction of OPERA by RR has been a key part of the evolution and will benefit many leased aircraft types going forward.”

It seems that much of the problem

Questions are being raised as to the affect of total care contracts on the resale market for aircraft. The A330, for example, is not yet enjoying the active secondary market that would be expected for its maturity.

with the remarketing of total-care-enrolled aircraft and engines has resulted from the first wave now entering or approaching second leases. Given the efforts of OEMs to respond to the plight of lessors and secondary lessees, it may be that, despite OEMs controlling even more of the aftermarket, the next wave of OEM-enrolled aircraft that mature and reach their second leases should not face the same problems detailed above. Razzhivina explains that FHA contracts were originally for a specific term, which means that only maintenance scheduled for that period is covered by the payments. Later FHAs offered life-long coverage for the engine, which eliminated the danger of shortfalls for operators past the initial term. “The latest development in the FHAs is to offer an ‘end-of-life’ solution, which minimises the maintenance cost and maintenance resource waste for older engines heading for part-out,” she says.

It is also easier to make maintenance more economic for ageing engines if they are not enrolled on total care contracts, and it has typically been a priority of the second lessee to move away from these agreements. “If the aftermarket is controlled to the extent that OEMs are directing who can perform maintenance and repairs, and supply materials, will OEMs even require secondary total care maintenance agreements for new-generation engines?” asks Bennett.

While Lessor Care has been raised as an example of increasing OEM flexibility, it is too soon to assess the extent to which this will improve the engine aftermarket for lessors. “Lessor Care has been rolled out by RR, but it is not yet prominent in the market,” says Ray. “Though AerCap is working on the structure with RR, the first customer is yet to be announced.”

Seymour also says that Total Care Flex has been a further attempt by RR to accommodate ageing engine economics. “It factors in the reliability of first-run versus second- and third-run engines,” he describes. “It allows maintenance with other materials, for example. The trouble is that for maturing and ageing engines, turnaround times for SVs are generally longer. More repairs are required. If OEMs are operating a closed market, they will have an influx of maturing engines requiring longer SVs of 75-80 days. A greater number of spare engines is therefore needed to support the market. “Initial spares levels for first-run



engines might not be sufficient for an operator with a large ageing fleet,” adds Seymour. “These are often accounted for in a total-care-oriented agreement. Operators of newly EIS engines might operate on 5% spares fleet coverage to account for the odd unscheduled SV, but as their engines mature this could increase to 15-20% spares coverage requirement as SV requirements increase. Both the OEM and the lessee need to account for this in the event of a long-term total care agreement.” While there have been some positive developments, questions remain.

The future

It may be that operators and lessees have less freedom today and in the future, to maximise the economy of ageing engine maintenance in modern and new-generation engines. Operators face increasingly closed markets, yet OEMs appear to be learning from their experiences, and trying to compromise on the long-term maintenance management by becoming more flexible. Part-outs have already been floated for the A380 for instance, as the secondary lease market already shows signs of struggle.

“Fewer MROs are licensed in the aftermarket for new-generation engines,” says Ray. “This will see fewer independent shops and less competition for operators to take advantage of. The use of total care narrows the market, which impacts values.”

“The buoyancy of the CFM56 market is an example of how an open market can drive the ultimate life and longevity of an engine fleet. New-generation engines, however, are designed with even longer TOW expectations, which further affects their aftermarkets. Regardless, ageing

engine fleets need protection,” adds Seymour. He also points out that operators still have the ability to control their engine fleet at an operational level to optimise SV patterns and make ageing engine fleets more economic.

Rubin says that liquidity drives the aftermarket, while Koppers adds that the best thing for operators and lessors is an aftermarket with healthy competition, and the freedom to choose providers.

“Ambitious production and maintenance plans have been set by some of the engine OEMs,” says Bennett. “This could imply that OEMs are gearing up to lead the aftermarket for in-production new-generation engines in the long term.” At peak activity, Bennett advises that the Trent 1000 will be undergoing SVs at a rate of one a day. Such activity will affect how much hold OEMs will be capable of maintaining as these engines mature.

This in turn will influence the take-up rate of future total care contracts for the global fleet, and the dynamics of remarketing assets. Bennett sees a future where all MROs will need to be aligned to the OEMs, to ensure that, regardless of ultimate lifecycle or long-term residual value of aircraft enrolled under OEM contracts, the MRO can be assured a share of the business. Whether this can translate to a healthy competition, which could in turn drive engine demands and values, remains to be seen.

It is clear that engine PBH and total care agreements have overhauled aftermarket dynamics, although improvements continue to be needed to maximise long-term market viability. **AC**

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