More airlines are outsourcing engine maintenance, and have to choose between fixed rate and time & material contracts. Fixed rate maintenance has the advantage of reduced airline input, while time and material means airlines have to maintain traditional engine management.

Considerations for third party engine maintenance contracts

A large number of airlines have outsourced or are outsourcing their engine maintenance. This presents operators with two choices: time and material contracts; or fixed rate, or 'power-by-the-hour' contracts.

Fixed rate contracts, which provide airlines with a predictable cost solution for their engine maintenance, have received considerable publicity. An added benefit of flat rate contracts is they can include a variety of services to enable airlines to reduce their engineering departments down to the legal minimum, thereby providing another cost saving.

Time and material contracts are a simpler process, whereby airlines pay engine maintenance vendors for time and materials consumed at shop visits when they occur. Airlines taking out such contracts maintain a larger engineering department because they retain the function of overall engine management and determine engine removal intervals and shop visit workscopes.

What type of engine maintenance contract should airlines therefore select, and what effect does each choice have on cos structure?

Elements of engine maintenance

The core of engine maintenance is the planned shop visits for the repair and overhaul of engine turbomachinery, which leads to a further decision regarding repair or replacement of turbomachinery parts.

The next major element is life limited parts (LLPs), which are limited by flight cycles (FCs), and are often between 15,000 and 30,000. LLPs in short-haul and high-cycle operations must be replaced every few years, which has a large impact on maintenance. Long-haul operations often mean that LLPs do not need to be replaced until 15-20 years of age, so airlines are less concerned with their cost.

Accessories (including gearboxes, fuel pumps and oil reservoirs) also require maintenance and are repaired during engine shop visits.

Line replaceable units (LRUs), such as starters and cables, are replaced during line maintenance.

The cost of this maintenance is accompanied by transport, spare parts storage and spare engine provisioning.

Engine maintenance also requires management, and involves condition monitoring and borescoping to determine timing of engine removals. Other issues of engine management are workscope planning, which is a process parallel to condition monitoring. Modifications, airworthiness directives (ADs) and service bulletins (SBs) must also be considered.

A traditional airline, with its own in-house maintenance facility, spare engines and engineering department will undertake all aspects of engine management and the majority of maintenance. Only high-technology and high-cost repairs may be sub-contracted.

Airlines mainly outsource engine maintenance because they do not have the economies of scale to justify their own engine shop. The most basic outsourced engine maintenance takes care of the core requirements for turbomachinery and accessory maintenance, as well as LLP replacement when required, but still leaves line maintenance and engine maintenance management to be considered.

Outsourcing engine maintenance necessitates a division of tasks between airline and maintenance provider. Engine maintenance providers not only offer varying levels of capability, from simple disassembly/assembly to full component repairs, but also varying levels of service. The range of services can include condition monitoring, borescoping, engine maintenance and modification status and management, shop visit workscope planning and spare engine provisioning. With sub-contracted maintenance, an airline must decide which of these additional services it wants from a provider and which it wants to retain in-house. While fixed rate contracts for engine maintenance have the attraction of predictable maintenance costs and reduced requirements from the airline, some carriers are wary of losing control over their engines and the possibilities of hidden costs.

Fixed rate contracts

Fixed rate contracts basically amortise the cost of shop visits over predicted on-wing intervals. This predicted reserve for engine maintenance cost has a profit margin added to it, but is intended to provide airlines with predictable maintenance costs. The agreement, however, carries risk for airline and maintenance provider. Shop visit costs and on-wing intervals can both vary, with amortised cost of maintenance per engine flight hour (EFH) being higher or lower than originally calculated. Higher than expected costs will penalise the provider, but better than expected performance can result in airlines paying more than required.

Engine maintenance providers have to make an accurate assessment of on-wing intervals, shop visit workscopes and shop visit costs. This is easier to predict for engines entering service, but gets

Fixed rate contracts can include a wide variety of services and airlines may be able to reduce their engineering departments to a minimum. Some airlines may be wary of losing control or hidden costs.

progressively more difficult as accumulated time on-wing increases.

Engine shops take into consideration aircraft utilisation, FH:FC ratio, expected engine de-rate and operating environment when predicting on-wing times. There are also other issues to consider. "The accumulated time on-wing, workscope of each shop visit and status of ADs and SBs incorporated into the engine will also affect engine reliability," says Andreas Kalina, director of sales and customer support for Europe, Africa and the Middle East at MTU Maintenance. Michael Rahmlow, regional manager of customer support engines at Lufthansa Technik adds that engine variant, each engine's maintenance history and special warranty agreements also affect engine cost per hour.

"There are also several other factors; including exhaust gas temperature (EGT) margin after shop visit, EGT margin erosion, remaining or 'stub' lives of LLPs, and the level of non-original equipment manufacturer approved repairs," explains Russ Shelton, general manager at General Electric Engine Services (GEES).

The pedigree of engines of the same variant also changes with operators, since different SBs and ADs will have been implemented. "Besides mission parameters; build standard, engine pedigree and future engine management with respect to modifications and shop visit workscopes influence on-wing performance," explains Randy Meek, finance director of aftermarket support at Pratt & Whitney (PW).

These factors all contribute to predicted or scheduled engine shop visits, but unscheduled visits for foreign object damage (FOD) must also be considered. "Assumptions have to be made about unscheduled visits for FOD, engine failure, earlier than expected component failures and faster than predicted wear and tear of the engine," says Ashley Cooper, chief executive officer of Total Engine Support. "A maintenance provider therefore makes an assessment of what removals it can plan for, and also an estimate of the unplanned removals."

Workscope determination

Workscopes and their costs will be determined by time on-wing to removal, previous workscopes, time expected or required on-wing following the shop visit, the engine's build and modification standard, LLP status and the degree of parts repair and replacement.

Workscopes will include LLP replacement for mature engines, although not all fixed rate contracts include the cost of LLP replacement. Cost of replacing LLPs can be charged as extra.

The most important aspect of services is the workscope planning for the engines, which must be included in most fixed rate services, since it determines cost, affects shop visit interval and actual cost per EFH. Maintenance providers therefore like to retain control of this. This is a joint effort between airline and maintenance provider in some contracts.

As well as workscope planning, shops will manage the engine removal process, since this affects their cost.

Maintenance providers bidding for fixed rate contracts will examine an engine fleet, estimate the number of scheduled removals and costs of shop visits during the contract and calculate an engine reserve rate.

Exact contract inclusions can vary substantially. "Besides maintenance of turbomachinery, accessories can be included. LLPs can also be included, but are not in most contracts," explains Kalina. "Contracts are complicated by the term, entry conditions and exit conditions of the engines. Analysis may reveal that shop visits are not due until after the contract period, or the last ones are predicted a few years before the end. This requires discussion of phase-in and phase-out conditions."

Cooper explains these difficulties can sometimes be overcome by performing the first shop visit during the contract of each engine with a standard workscope and billing on a time and material basis, with a fixed rate starting afterwards. "In reality airlines want fixed rate from the start," says Cooper.

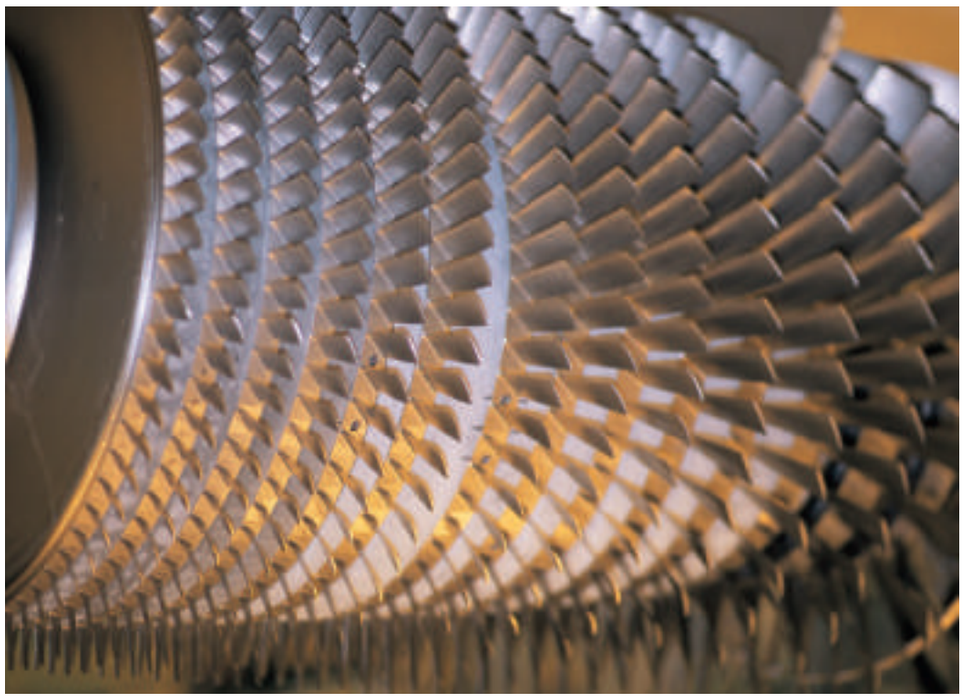
Entry & return conditions

Fixed rate contracts are complicated by the maintenance condition and estimated time to first shop visit of engines at the start of a contract, and the time since last shop visit and maintenance condition at the end.

Engines with less than a full interval to go to the next shop visit at the start will require a high reserve from the airline than if they had the full interval to run. Similarly, contracts terminating when engines are time-continued and have not completed a full on-wing interval, will have had reserves paid but will then not receive any maintenance in return. "This complication requires phase-in and phase-out conditions," says Kalina. "There may be a case in a 10-year contract that shop visits occur in the eighth year, with reserves being paid in the last two but no maintenance is performed. The easiest way around this is to consider the total EFH during the term for the fleet and the predicted cost of the expected shop visits and calculate a reserve. Reserves paid for an engine with a shop visit say two years before the end of the contract will make up for the cost of shop visits performed earlier."

This raises the problems engine shops face. An ideal situation is where reserves are paid and all shop visits are at the end of the term. Cooper highlights that shop visits grouped together early in a contract result in negative cashflow for the maintenance provider initally, which must be repaired with reserves paid later.

In addition to the maintenance and repair of engine turbomachinery, condition monitoring and workscope determination are the minimum services that have to included by a maintenance provider.



Despite an average reserve being paid over the term for a fleet of engines to resolve the difficulty of timing of shop visits and payment of reserves, issues remain concerning the risks of more or less shop visits than predicted being required, and the entry and return conditions of the engines.

A lower than predicted number of shop visits will benefit the maintenance provider, which is a risk factor for the airline. Engine shops rarely make serious prediction errors, and savings are only passed on to airlines if the number of shop visits in significantly lower than predicted.

Maintenance condition of engines at entry is easy to assess at the start, but harder for mature engines. Exit conditions are just as difficult. "If the term of the contract is short a shop will specify the condition it will return the engine in, and there may be reconciliation of funds," says Cooper. "The longer the contract the higher the risk and shops generally do not specify return conditions, because they are hard to predict. Other difficulties arise when lessees default on a leased aircraft, making it hard for lessors to reclaim reserves from providers."

Many fixed rate contracts for new engines often only extend a few years, and terminate before most engines are removed for their first shop visit. Reserves have been paid and are non-refundable, while no shop visits have been made. Airlines are then obliged to re-new contracts, but many with higher rates.

Modifying fixed rates

Fixed rates paid relate to predictions. Actual engine performance may be better or worse than predicted. "It is possible to revise calculations as new data is acquired," says Rahmlow "but contracts include assumptions about performance and providers have a margin of error built into the rate. Differing performance is a risk for both sides, and refunds are not made. Only changes to the operating parameters result in the re-negotiation of terms and maintenance reserve."

Shelton explains that once expected mission parameters have been established, GEES uses a sensititvity matrix for changing operating conditions. "We look at an airline's actual operation every month. With engine diagnostics we can update operating data all the time," says Shelton.

Variation in engine performance and shop visit costs, other than changes in operating parameters, involves risk for both parties. Maintenance providers also have to build in a profit margin, and so add margin of error into fixed rates. Cooper explains shops will target a margin of 10-20% in their rate per EFH to take account of actual maintenance cost risk and profit margin.

Fixed rate services

These are the basic parameters for determining the engine reserve per EFH. Other elements of maintenance and engine management can be added. "We offer condition monitoring and relevant supporting tools, although we normally prefer that customers do this themselves," says Kalina. "We can advise customers when to remove engines if the right equipment is on board the aircraft to provide us with data."

Condition monitoring is an essential part of predicting engine removals, and therefore reserves, and so must be included as an element of a fixed rate contract. Airlines can perform this themselves and provide data to shops.

Transportation is another possible addition, as is access to a pool of spare engines to cover for planned or unplanned removals too. "We normally include propulsion engineering, which is advice on which SBs are economical to incorporate," says Rahmlow.

Modifications, SBs and ADs complicate the issue of maintenance and fixed rate contracts. Simpler and smaller SBs will have little effect on engine performance, but are incorporated to keep the engine's status similar to all other carriers. "Certain SBs and ADs will be performed under an agreed baseline", says Kalina. "Additional ones published after the contract signing can improve the engine's performance. These may then be added to the shop visit workscope at extra cost to the airline, since they fall outside the pre-agreed baseline. Because modifications can improve engine performance and reduce maintenance cost per EFH, airlines will want a reward for paying for these improvements and the contract has to be renegotiated."

"We work with customers to continually drive down the cost of engine maintenance, so we can introduce an upgrade to an engine that drives down cost or improves time on-wing," says Shelton. "We can then modify fixed rates if engine costs turn out to be better than expected."

On-wing repairs are often included and performed by the provider. These small repairs can limit removals and maintenance cost.

Some elements of maintenance can either be included or excluded. An example is coverage or insurance for FOD damage. "Some airlines can pay what is effectively an insurance rate to cover up to a certain percentage of all removals due to FOD," says Kalina.

Some contracts only concern the repair of parts. "This is the case with shops that have the capability to disassemble, inspect, re-assemble and test, but cannot perform repairs," says Meek. "We then offer these shops fixed rate contracts for material management."

Time and material contracts divide the responsibility of maintenance and engine management clearly between maintenance provider and airline. While airlines have the cost of management, it is now possible to sub-contract these services to independent advisors.

Fixed rate service exclusions

The first exclusions in fixed rate contracts are failures caused by design failures of parts, which result in shop visits that cannot be predicted. Shop visits caused by accidents and misuse of engines are also excluded. Removals and shop visits due to FOD are also often excluded. Airlines can either pay a higher fixed rate to effectively provide an insurance coverage, pay an insurance premium to cover these eventualities or pay for the shop visits on a time and material basis as they occur.

Airline responsibility

Although there are some exclusions in fixed rate contracts, these are all related to unpredictable shop visits. Maintenance providers offer customers a menu of services in addition to the basic engine and accessory maintenance and workscope and removal planning.

This allows airlines to minimise the resources they require for engine maintenance and its management. Airlines are still legally responsible for their operations. "Airlines must still have a technical department to officially manage their engines," says Cooper. "This is to maintain a certificate of airworthiness. This requires airlines to keep condition monitoring, maintenance status records and operate an engine reliability programme. Airlines also have to demonstrate they are still managing the shop visit workscope process."

Other issues are also important, such as a maintenance programme for engines used in Etops missions. "This all still requires a technical and engine management department," says Shelton. Items such as LLP tracking is also required, as are AD and SB status, records for accumulated EFHs and engine flight cycles (EFC).

"Although airlines still have to maintain a minimum staff, fixed hour agreements reduce airline costs because they do not have to order parts and do not need staff to manage the shop visits and carry out workscope planning and invoice analysis," says Kalina. "This probably means airlines can halve their engine administration staff." Airlines also need to have a close relationship with their maintenance providers, since decisions must be made regarding removals, modifications and communications made regarding in-service problems. Airlines still also perform line maintenance, and so replacement of LRUs.

Time & material contracts

The principle of time and material contracts is that engine shops are required to perform shop visits at an airline's request. The airline determines engine removal dates and shop visit workscopes, thereby maintaining control over the management of its engines.

This requires airlines to maintain an expertise for engine management and the monitoring of shop visits, and they carry all the risk of engine maintenance. "Unlike fixed rate contracts, time and material keeps the control of maintenance in-house," says Cooper.

This puts the onus of achieving the lowest possible maintenance costs with the airline. Airlines are therefore required to have substantial engineering departments and staff with the right skills to keep engine maintenance costs to a minimum. Although this incurs overheads, fixed hour contracts do not just include the costs of maintenance, but also a cost element for all the services the contract provides.

"The staff an airline would need to have for time and material engine maintenance would be a technical group, staff to maintain control of maintenance in the engine shop and auditing against shop invoices," explains Cooper.

Airlines and engine shops are thus effectively divided between roles of management and pure maintenance. Fixed rate contracts, in contrast, hand a large part of engine management to maintenance providers. In particular this is workscope planning and inputs, modifications and overall build standards.

Time & material vs fixed rate

Despite the advantages of predictable cost for basic engine maintenance and reduced engine management that fixed rate contracts provide, airlines have reservations about these arrangements. "We did not have the economies of scale to justify our own engine maintenance, so we have outsourced some using fixed rate contracts," says Joe Van Niekerk, manager of technical marketing at South African Airways. "Fixed rate providers determine workscopes and engine build standards to maintain their own cost targets. We have found that this can result in poorer build standards compared to what we had in the past. Consequently, factors like EGT margin tend to be lower and deterioration rates higher. While this itself does not affect fixed rates paid for maintenance, it increases fuel burn, bringing up a hidden cost.

"Maintenance shops also do not necessarily build the engines to zero life, and this can affect reliability and the rate of unscheduled failures. A higher rate of removals is bad for us with our geographical position, since transport costs to major engine shops are high. Additional engine removals have raised this cost, bringing up another hidden cost," continues Van Niekerk. "Increased removals and shop visits also increases our spare engine requirements, raising extra costs. We also lose control, since we do not always get the same parts back with an engine, and some of these are repaired." AC