Few regional airlines perform much of their own maintenance. The focus is now on sub-contracting all work, except for line checks. How should airlines subdivide and manage their maintenance to achieve their lowest costs?

Managing regional aircraft maintenance costs

As their focus has moved away from engineering organisations to transport providers, almost all regional airlines have become increasingly dependent on the use of third parties for their maintenance requirements.

For the regional operators this has extended to the supply of a comprehensive range of support services. Also, because of the smaller number of aircraft in the fleet and the greater sensitivity to one-off costs, they have increasingly adopted fixed price, power-by-the-hour (PBH) programmes.

To consider how a regional airline manages the maintenance of its aircraft it is necessary to understand both how maintenance is broken down and what are the different options available for each of these elements. For most elements of maintenance discussed there are two options available, the first is to pay as you go and the second is the PBH approach.

Line maintenance

This covers routine servicing, checking fluid levels, tyre pressure and visual inspections. All aircraft and engines have a minimum requirement for such maintenance, which is defined within the maintenance review board document for each type. Line maintenance can be assumed equal for similar types, since staff have to be available to perform the line maintenance on a daily basis, irrespective of which aircraft type is operated. The majority of operators will undertake their own line maintenance. Exceptions include where an operator has outstations with limited frequency of service. It is outsourced to either another local operator or a dedicated maintenance company.

Base maintenance

Typically, this covers major systems inspections, structural inspections, corrosion inspections and modifications. For the structural inspections, in particular, specialised equipment is required. This, and its infrequent nature, makes base maintenance uneconomic for small fleet operators to undertake on their own. Regional operators are therefore dependent on third-party facilities. In some cases the latter will be independent facilities, but usually they are either larger operators or the manufacturers.

It is difficult to obtain absolute cost control on base maintenance, due to an inability to predict what defects will be uncovered during inspections. Maintenance providers will charge a fixed fee for the inspection based on their knowledge of how long it takes to carry out all the tasks required by the check in question. During these inspections defects are discovered that require non-routine rectification, and extra costs are incurred. For new aircraft undergoing their first C check, for example, the ratio of non-routine rectifications is low. In the first few years, the non-routine manhours (MH) will be up to a ratio of 0.8:1.0 of routine work.

For a 20-year-old aircraft the routine MH are small in comparison with the non-routine portion. The ratio of non-routine to routine can climb to as high as 2.5:1.0. Therefore, fixed-price inspections do not necessarily result in an inspection with a fixed price.

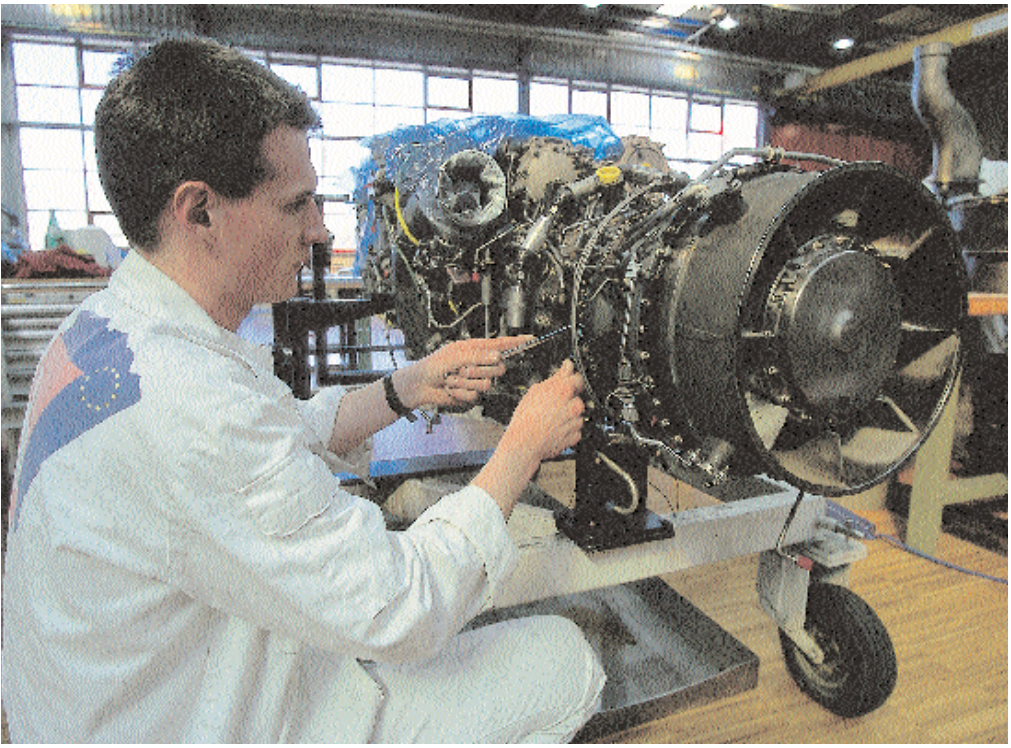
A variation on a simple fixed-price inspection is where the maintenance provider includes an allowance for defect rectification up to a certain number of MH per task card or year, along with a certain material cost limit. These type of agreements have few improvements over the basic fixed-price inspection, since the operator will still be responsible for any excess. Obviously, this form of agreement will be more expensive than a simple fixed-price inspection.

Airframe rotables

Repair of airframe rotables is left almost entirely to the original equipment manufacturer (OEMs) and the specialist repair centres. The likelihood of a regional operator having any significant capability for the repair and overhaul of rotable components is extremely small. Since this activity will constitute hundreds of separate components for any aircraft type there is also a significant burden for the operator in dealing with many different suppliers and repair centres. For the smaller organisations characterised by the majority of regional airlines this is an added attraction of the all-inclusive repair and overhaul packages being offered.

As well as the OEMs, several other organisations offer competing services. On the larger regional aircraft, for example, CASCO in the UK offers an equivalent scheme to BAE Systems' Jetspares programme for the BAe 146. In France, TAT offers schemes for the Fokker 100, equivalent to those provided by Fokker Services. On the Fokker 50 turboprop, competition comes from Celsius.

As a further alternative airlines can engage the specialist services of companies such as Airinmar which, while it does not control repair shops of its own, manages the process on behalf of the operator. Airinmar actually provides this service to BAE Systems in support of the Jetspares and Macro programmes offered on the BAe 146, Avro RJ, Jetstream 31/32/41 and ATP.



The problem with engine maintenance is that costs start low in the first year and continuously escalate until LLPs need replacing. All-in PBH programmes avoid cost peaks and nasty surprises.

Under normal circumstances, when a component requires repair or overhaul under the terms of a fixed price agreement, it will simply be transported to the maintenance provider and in due course get repaired and returned to the operator. Two important areas to be considered, then, are the availability of spares while the original component is undergoing repair/overhaul, and the frequency of components that are beyond economic repair (BER).

Spares

Many of the programmes available cover both fixed-price repair and overhaul, and the supply of an on-site leased stock of aircraft-on-ground spares with access to a rotable exchange pool at the suppliers' main warehouses.

There are two principal downsides to the traditional method of acquiring spares and covering repair and overhaul costs as they are incurred.

First, a large investment is required to acquire the initial provisioning, and second there is no way to predict the costs of repair and overhaul accurately. For the larger fleet operators this variability averages out over the fleet, but for a typical regional carrier with only a few aircraft, the effect can be very damaging. Fixed-price repair and overhaul agreement, together with access to spares, guarantees a flat cost per flight hour (FH) profile. While the benefit of guaranteed outgoing cashflow is significant for the smaller regional operators, the reduction in up-front investment is probably equally important.

In the past, the leasing of spares was not very popular, since it was almost impossible for the owner to keep track of a leased spares stock. Airlines can now lease inventories from specialist providers, which also manage the repairs on a PBH basis.

Under a typical repair and overhaul agreement the service provider now effectively controls the spares. For the operator there is the obvious benefit that it no longer has to invest its own inventory. Since it has access to a far larger pool it will also reduce the time it has aircraft on ground.

With a forward exchange service, once a part needs replacing, the new component is dispatched as soon as it is requested, without any wait for the old one to be received.

These fixed-price repair and overhaul schemes relieve the operator of much of the administrative burden. Other benefits are that the obsolescence of spares and depreciation are no longer factors, since this is the responsibility of the service provider. Also, mandatory service bulletins are generally included.

In the event that a component is deemed to be BER, the operator is normally responsible for its replacement. Reference is usually made to a percentage of the new component price. If the repair is expected to cost between 60-70% of the new price, it is deemed BER.

A new aircraft is sold with warranties. To gain the maximum benefit from a fleet of new aircraft the operator has to be able to make all possible claims under the warranties given with the aircraft. This can be a time-consuming administration process. One of the benefits of the manufacturers' maintenance programmes is that they take account of this effect. Some manufacturers will simply reduce the hourly rate for the duration of the agreement while others actually simulate the warranty effect by implementing a phased hourly rate.

The better of the maintenance agreements will include a clause whereby if the operator achieves a better-than-average removal rate on the components covered by the programme, it will receive a commensurate reduction in the rate. This is a double-edged sword, since an increase in the removal rate will have the opposite effect**.** As an indication of the cost savings that can be achieved, one source quoted a reduction of up to 7.5% as being achievable for an operator with a low unscheduled removal rate.

With all the various programmes there may be entry fees to be paid when considering used rather than new equipment. These are particularly applicable when high-value items such as the landing gear are included. The service provider will not want to exchange a component within a few weeks of the commencement of a repair and overhaul agreement. At this point it will not have collected enough payments to cover such an expensive item.

Miscellaneous materials

These are generally parts that do not have individual serial numbers and for which there is no possibility of repair or refurbishment. They are typically lubricants, seals and fasteners. Such parts are always excluded from by-the-hour maintenance contracts, since they are so open to misuse. With some programmes, including Jetspares, an initial stock of consumables is provided with the intention that the operator keeps it stocked.

Wheels, tyres and brakes

These are generally considered as heavy components and are worthy of separate consideration since they are a significant cost driver. They are usually excluded from by-the-hour maintenance contracts, since they are so open to different operational procedures and misuse.

As a practical example, one manufacturer quoted its experience with the brake life of two European operators that are both members of its repair and overhaul programme. One operator is able to achieve over 2,000 landings between brake pack replacements, while the other cannot manage 1,000.

One other OEM actually withdrew its

fixed-price landing-by-the-hour programme when it began to lose too much money.

Landing gear

Landing gear overhaul is sometimes covered within the repair and overhaul programmes, but, again, OEMs offer equivalent programmes. Where an operator elects not to take part in such a programme it is prudent to set up a reserve fund to cover the cost of overhaul.

On a new or substantially modified derivative aircraft, setting aside sufficient funds to cover the landing gear overhaul when it occurs is complicated by the lack of a mature overhaul interval. This will initially be set at a conservative level and, as experience is gained on the fleet leaders, it will be extended. Overhaul costs will increase as the time between overhauls increases, but cost per landing will come down.

Engines

The increasing complexity of modern aero engines and the resultant large investment required to set up dedicated overhaul facilities has seen the majority of even the world's major airlines contracting out their engine overhauls. The number of regional operators with a significant capability is extremely small, limited to the likes of Crossair.

Without exception, all of today's engine manufacturers offer PBH programmes of some kind. Programmes are always for a fixed duration and the rate is based on the number of overhaul events expected over the duration of the agreement. These can cause significant disagreement between lessee and lessor, since the lessee may be able to buy in to a short-term PBH agreement, which will not cover the more expensive shop visits that come later.

If an operator elects not to enter a PBH programme on its engines it becomes exposed to high fluctuations in costs. Due to the long time between overhauls of today's engines, an operator will experience low costs for the first few years. Most will be related to the repair of line replaceable units (LRUs). At engine overhaul the operator will then be faced with a large cost amounting to hundreds of thousands if not millions of dollars. If the operator took delivery of several aircraft at the same time then this cost will be multiplied, since many engines will all come due for a shop visit within a short time period.

Engine LRUs, full authority digital engine control (FADEC), fuel pumps and accessory gearboxes, are usually excluded from a basic PBH agreement with the manufacturers. They can be added as an optional extra.

One area of maintenance cost that is wide open to abuse is that of engine life limited parts (LLPs). Prudent operators will simply package the LLP reserves into the manufacturers' PBH programme or set aside their own reserve funds. The fact that these costs may not arise for 10 years or more results in some airlines simply neglecting them until it is too late to avoid a very high cost.

Competition

An important factor for an operator when considering whether or not to enter into a PBH-type agreement is the level of competition available in the overhaul market for the engine type. A good demonstration of this is given by comparing the General Electric (GE) CT7 engine that powers the Saab 340 versus the Pratt & Whitney (P&W) Canada PW100 that powers the equivalently sized Brasilia, Dornier 328 and Dash 8-100.

GE offers its engine care and maintenance programme (ECMP) for both the CT7 and CF34 engine families. The ECMP was the outcome of the problems that arose with the

100-SEAT REGIONAL JET MAINTENANCE COSTS UNDER THREE SCENARIOS

Maintenance element	Scenario I ($)	Scenario II ($)	Scenario III ($)
Line maintenance	50/FH	50/FH	50/FH
Base maintenance-routine inspections	25/FH	50/FH	50/FH
Base maintenance-non-routine defect rectifications			50/FH
Rotable repair & overhaul	50/FH	100/FH	100/FH
Beyond economic repair rotables			25/FH
Consumables-A, C & structural checks	25/FH	25/FH	25/FH
Wheels, tyres & brakes	50/FH	50/FH	50/FH
Landing gear overhaul		25/FC	25/FC
Landing gear replacement			25/FC
Engine overhaul	150/FH	200/FH	200/FH
Engine LRUs	25/FH	25/FH	25/FH
Engine LLPs		50/FH	50/FH
Total	375/FH	575/FH	675/FH

CT7 on its entry into service on the Saab 340.

To overcome the resultant lack of confidence in the engine, GE was forced to offer this at fixed price PBH. The ECMP has proven to be extremely popular with the majority of operators enrolled. In view of the limited number of CT7 engines in service (the only other commercial applications have been a limited number of Airtech CN-235s) there are only a limited number of overhaul facilities around the world. This, in turn, has limited the amount of price competition and encouraged operators into the ECMP.

In comparison with GE's CT7, the P&W Canada PW100 family has been far more successful, with a total of eight major regional applications (ATR42, ATR72, BAE ATP, DHC Dash 8-100/-200, Dash 8-300, Dornier 328, Embraer EMB-120 and Fokker 50). The result is that there are far more overhaul facilities available. For many operators it is more sensible to play the field when engine overhauls become due.

Aircraft ownership effect

The way an airline organises its maintenance is also dependent on the way in which it has acquired its aircraft. If the operator has simply purchased the aircraft, either outright or under long-term financing, then it will be free to cover the maintenance costs of its aircraft in any way it feels appropriate. If it has leased the aircraft from a third party then the lessor will almost certainly demand that the airline pays maintenance reserves. These will typically cover the more expensive, long-term cost items such as structural inspections, engine overhaul, engine LLPs, landing gear overhaul and auxiliary power unit.

If the operator pays these reserves in this way, it will only be necessary to ensure they are paid every month. Some confusion arises when an operator has aircraft within a fixed-price repair and overhaul programme, which includes elements that are also covered by the reserve payments being made to the lessor. Obviously the airline does not wish to pay both the lessor and the maintenance provider for the same work. In these cases interesting discussions take place between the three parties, with a tripartite agreement usually the end result.

Tax considerations

An important consideration for an operator that does not enter into a PBH programme on its engines, in particular, is that of tax liability. An operator will experience low engine maintenance costs for the first five years of operation. Even with a dedicated reserve fund in place this operator might be seen to be very profitable and could then be subject to tax. Taxation law varies widely, but where local tax law does not protect reserve funds then a PBH agreement, including the LLPs, is a convenient way for an operator to avoid unnecessary taxation.

Conclusion

Fixed-price maintenance programmes began largely as a way of guaranteeing manufacturers' maintenance cost projections: in effect it is an insurance policy for the operators. The programmes originally tended to cover repair and overhaul, but have grown to include all-inclusive packages, leaving the operator with little more than line maintenance to organise.

Regional operators now have the option of controlling the majority of their maintenance under these PBH-type support services.

The table *(this page)* summarises the first five years of maintenance costs for a notional new 100-seat regional jet under three separate methodologies. This aircraft will not be due any structural inspections during this period, only A and C checks. Levels of utilisation mean a C check interval can be stretched to almost two years. The OEMs will provide their own PBH C checks, and perhaps also the A checks.

Engine OEMs provide similar deals for shop visits, and the first removals will incur light workscopes. Landing gear will not be removed during this period.

In the first scenario the operator simply pays for expenses as they are incurred. A and C checks have low non-routine ratios, and so base maintenance and consumable expenditure is low. Engine shop visit workscopes are light and intervals probably the longest. Engine LLP s do not require replacing and landing gear is not removed.

After the five-year period costs will escalate. The first heavy check will have to be done and non-routine ratio will climb. Engine shop visits will get heavier.

In the second scenario the operator takes advantage of PBH-type programmes to the extent that they are available. These only provide PBH rates, however, for items that actually come due during the five-year period. This does not include landing gear overhaul, structural checks and engine LLP replacement, for example. Cost will still then escalate in later years as these items come due.

In the third scenario, the operator takes full account of all the costs that will occur over the economic life of the aircraft, setting aside reserves for cost items that will only occur in the later years. These smooth out costs so that the maintenance provider does not use all the reserves paid in the first five years, but has the funds for them later on.

This example highlights how maintenance costs can vary during the first years of operation, from $375/FH to $675/FH, depending on how an operator treats long-term items.