**The 767's maintenance programme is modular and complex. This often prevents operators achieving high utilisation of check intervals, but the aircraft nevertheless has low maintenance cost per flight hour for airframe checks and component repairs compared to older generation widebodies.**

# 767 delivers low-cost airframe & component maintenance

The 767's success is hard to ignore. There are nearly 800 units in service. This article analyses the airframe and component maintenance costs of the -200 and -300 series passenger aircraft, and how these accrue per flight hour (FH).

The 767 operates in a variety of forms. This includes passenger, freighter and converted freighter models. Within each of these sub-types there are aircraft equipped with different engines that have varying specifications with respect to gross weight, types and numbers of passenger and freight doors, and modifications for Etops operations.

## Maintenance costs

To analyse the 767's maintenance costs per FH all maintenance tasks need to be accounted for, their FH periodicity determined and the inputs for each task assessed.

This article will consider the 767-200/-300's maintenance costs on the basis of operation on two levels of utilisation. The first is with a mixture of route lengths and FC time of 4.0FH and annual utilisation of 3,000FH and 750FC per year. The second considers aircraft operating exclusively on long-distance sectors, with an average FC time of 8.0FH and annual utilisation of 5,000FH and 625FC.

The tasks for airframe and all component maintenance can broadly be divided into three categories: line maintenance, airframe checks and component maintenance.

The 767's operation varies widely and maintenance costs are primarily affected by aircraft utilisation. The 767 is commonly used on short, medium and long routes by the same carrier. One example is British Airways, which uses its 767-300s on routes as short as London-Paris and as long as London-Dubai.

Average flight cycle (FC) time and annual FH utilisation will influence maintenance costs. Operations with mixed route lengths will have average FC times of 3-6FH. Alitalia operates long-haul sectors and its 767s' average FC time is about 8.0FH. Annual utilisation averages about 5,000FH and 625FC per year.

Gulf Air performs multiple stops in the Gulf region as part of its longer distance routes. Gulf Air's aircraft operate an average cycle time of 3.0FH and a total of 4,200FH and 1,400FC per year.

## Maintenance schedule

The 767's maintenance schedule is often described as being modular. Besides line checks, the 767 has A and C checks. A and C checks are then subdivided into system and structural checks. These four basic groups of checks are independent and have their own intervals. They can therefore be performed together or separately.

## A check

There are five work card packages for system A checks. These are the 1A, 2A, 3A, 4A and 6A packages. These have a basic interval of 500FH. That is, the 1A package has to be performed every 500FH. The 2A must be completed every 1,000FH, or with every second 1A package. The 3A, 4A and 6A packages have corresponding multiple intervals of 500FH.

There are several ways in which the A system check packages can be organised. "One way is for an airline to equalise the A check packages into equal portions. That is, the 2A is split in two halves, the 3A into thirds and similarly the 4A and 6A packages into appropriate portions. This way a standard A check package is derived *(see table, page 29)*. These have an interval of 500FH," says Jude De Motte, maintenance planning engineer at GAMCO.

This method derives twelve checks, A1 to A12, to be performed, despite there only being six A check packages. This is explained by the second quarter of the 4A package being performed at the A6 check. The fourth quarter of the 4A check will coincide with the A12 check.

It will then take 6,000FH to complete a full equalised system A check cycle.

Alternatively each system check package can be performed when each comes due, resulting in different sized A checks, with the same 500FH interval. This way a full system A check cycle will be completed every 3,000FH.

There are two workcard packages for structural A checks. The S1A has to be repeated every 300FC, while the S5A is completed at 1,500FC or every fifth S1A package.

The varying average FC times of 767 operators means the system check that is performed with the structural check package can vary *(see table, page 29)*.

The system check multiple at which the S1A and S5A checks are performed is determined by the aircraft's average FC time. Because the S1A's interval is 300FC, for maximum use of its interval it can only be combined with every systems A check if the aircraft has an FC time of up to 3.2FH or 960FH. A higher average FC time of 3.3-5.0FH will mean the S1A will be more efficiently combined with every second systems A check *(see table, this page)*.

The same principle applies to the S5A check. The table *(see this page)* shows the range of average FC times that match the systems check multiple that the S1A and S5A checks should be combined with to get the most efficient use of their FC intervals.

Aircraft analysed here with an average FC time of 4.0FH will then combine the S1A check with every second systems check (1,000FH) and the S5A check with every tenth systems check (5,000FH).

An aircraft with an 8.0FH cycle time will combine the S1A and S5A checks with every fourth and 20th systems checks (every 2,000FH & 10,000FH).

An aircraft with a medium rate of utilisation of 3,000FH/750FC per year will need to perform a system A check about once every two months.

An equalised A check system, which requires 6,000FH, will be completed about once every two years. Only one year will be needed to complete a non-equalised A check package.

An aircraft with a high rate of utilisation at 5,000FH/625FC a year will complete a fully equalised system A check cycle every 60 weeks. A non-equalised system A check cycle will be completed about once every 30 weeks.

## C CHECK

There are four systems C check packages and also four structural C check packages.

The interval of the systems package (1C) is 6,000FH and 18 months, whichever is reached first. A full systems C check is therefore completed every 24,000FH or six years.

The structural interval (S1C) is 3,000FC or 18 months. The full cycle is completed every 12,000FC or about six years.

Again, because of varying average FC times, combining systems and structural checks is complicated. Most carriers will perform systems and structural checks together to minimise downtime, and sacrifice a portion of the structural C check interval.

An aircraft completing 3,000FH and 750FC per year will require a systems C check every 4,500FH and 1,125FC because of the 18-month limit. It will also achieve about 18,000FH and 4,500FC every system C check cycle.

Despite only 1,125FC being completed in the 18-month interval, a structural C check will also be required. The 1C and S1C will therefore be combined for this aircraft.

An aircraft achieving 5,000FH/625FC a year will require a systems C check about every 60 weeks, because of the 6,000FH limit. It will complete the 24,000FH C check cycle limit in about 240 weeks, or about every 4.6 years.

Again, despite only 625FC being completed in 60 weeks, the S1C will have to be combined with the systems 1C because of the S1C's 18 month limit. The S1C could be performed separately, but systems and structural checks will get out of phase.

"Airlines now prefer to combine systems and structural checks. This is preferable, because additional aircraft downtimes can interfere with busy scheduling periods. Gulf Air, for example, typically has a C check performed every 17 months and 5,950FH and 1,983FC," explains De Motte.

Like A checks, C check packages can either be equalised, or performed as complete blocks when due. "It is theoretically possible to equalise packages," says Peter Cooper, senior planning engineer at Shannon Aerospace. "That is, equalising the systems checks will result in a C check with the 1C, half the 2C and a quarter of the 4C performed each time. The 3C package is small and thus not equalised, so it is performed every third check.

"A few airlines do this systems check equalisation, but most perform the full packages when due. They also combine corresponding systems and structural packages. The 3C and S3C checks are therefore performed together every third C check. The second time around they'll be performed at the sixth C check," explains Cooper.

The organisation of systems and structural C checks is summarised *(see table, page 30)*.

KLM Engineering & Maintenance takes advantage of the 767's modular maintenance schedule. Dick Stegenga, senior project engineer Boeing 767 at the company explains."We translate the MPD into maintenance requirement items (MRIs), which together with company requirements make the basis for the maintenance programme. The MRIs show the maximum interval of each task.

"The process of preparing job cards and predictable maintenance packages is aided by our computer system Amical. This builds equalised packages, which are pre-ceded with an F. Such a package has an interval controlled by its major contents. This make downtimes predictable and combines maintenance more effectively with our flight schedule or our customers.

"We have integrated the S1A and S5A checks into the system A checks, which we have equalised into FA checks. These have an interval of 650FH and 250FC; whichever comes first. The system C items and their multiples are equalised over eight packages and spread over the FAs in such a way that the system C items' intervals are satisfied. The FA interval utilisation is 95% or better," continues Stegenga.

### 767 SYSTEMS AND STRUCTURAL A CHECK ORGANISATION

Equalised systems A check content: 1A, 1/2 2A, 1/3 3A, 1/4 4A & 1/6 6A.

| | | | | | |
|---|---|---|---|---|---|
| Systems A check interval-FH | 500 | 500 | 500 | 500 | 500 |
| Systems A check with which S1A check is performed | 1st | 2nd | 3rd | 4th | 5th |
| S1A check interval-FH | 500 | 1,000 | 1,500 | 2,000 | 2,500 |
| S1A check interval-FC | 300 | 300 | 300 | 300 | 300 |
| FH : FC ratio | to 3.2 | 3.3-5.0 | 5.1-6.6 | 6.7-8.3 | 8.4-10.0 |
| Systems A check with which S1A check is performed | 5th | 10th | 15th | 20th | 25th |
| S5A check interval-FH | 2,500 | 5,000 | 7,500 | 10,000 | 12,500 |
| S5A check interval-FC | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |
| FH : FC ratio | to 3.2 | 3.3-5.0 | 5.1-6.6 | 6.7-8.3 | 8.4-10.0 |

**767 SYSTEMS AND STRUCTURAL C CHECK ORGANISATION**

| C check | Systems & structural packages | CPCP & sampling | Interval FH/FC/months |
|---|---|---|---|
| C1 | 1C & S1C | | 6,000/3,000/18 |
| C2 | 1C, 2C, S1C & S2C | | 12,000/6,000/36 |
| C3 | 1C, 3C, S1C & S3C | | 18,000/9,000/54 |
| C4 | 1C, 2C, 4C, S1C, S2C & S4C | Initial CPCP | 24,000/12,000/72 |
| C5 | 1C & S1C | Repeat S1C CPCP | 30,000/15,000/90 |
| C6 | 1C, 2C, 3C, S1C, S2C & S3C | Repeat S1C CPCP<br>Repeat S2C CPCP | 36,000/18,000/108 |
| C7 | 1C & S1C | Repeat S1C CPCP | 42,000/21,000/126 |
| C8 | 1C, 2C, 4C, S1C, S2C & S4C | Repeat S1C CPCP<br>Repeat S2C CPCP<br>Repeat S4C CPCP<br>Initial S8C CPCP | 48,000/24,000/144 |

KLM then treats the structural C checks separately. "The S1C, S2C and S3C are also equalised into what we call 'FC checks'. This way we are able to get 85% of the 18-month interval of the structural C check," says Stegenga. "The S4C is then performed once every 72 months, and we refer to this as our 'FD' check. This is combined with whichever 'FC' check is done".

## CPCP & sampling

The C checks are further complicated by the corrosion prevention and control programme (CPCP) and structural sampling programme.

The initial CPCP work package has its threshold at the first S4C interval, that is, 12,000FC and 72 months. After the initial inspection is performed these job cards are then broken down into three groups for repeat inspections. About two thirds of the cards then go into the S1C, and so are performed at each structural C check; 3,000FC and 18 months.

"The second group has a repeat interval of S2C; every 6,000FC or 36 months. The remainder of the cards are repeated at S4C; every 12,000FC or 72 months or the S8C check," says De Motte.

There is also another group of CPCP cards that are performed every second S4C  check (S8C); every 24,000FC or 144 months. These intervals means they are only likely to be performed twice in the aircraft's lifetime. This group of cards is very heavy.

Cooper explains that in some cases job cards can be performed initially at the sum of their initial and repeat interval. For example, S4C plus S2C equals 18,000FC or nine years.

The sampling programme is lighter than the CPCP. One set of job cards is performed at the systems 4C check; one in 10 aircraft are affected. There are also two groups of structural cards done at the S4C check. One group affects one in 10 aircraft and the second group one in five aircraft.

"There is also a small number of out-of-phase job cards, and these are performed with A and C checks," says De Motte. "The CPCP and sampling programmes are added to the C checks to make larger checks and they get larger in content as the aircraft ages".

There is also an integrated structural inspection programme to be published for the 767. "This will basically be a way of incorporating structural C checks and CPCP tasks, which is a modern way of planning tasks," says Cooper.

## MH inputs

Man-hours (MH) to complete the checks can be estimated with reasonable accuracy.

The size of A checks means the amount of MH required can be approximated. About 550 MH are needed for an equalised system A check. About another 40MH will be necessary for the S1A check. The total for each A check will then depend on the occurrence of S1A checks. This will be scheduled every second A check for aircraft operating a 4.0FH flight cycle, but every fourth A check for an aircraft operating an 8.0FH cycle *(see table, page 35)*. The S5A check consists only of two cards and requires about 10MH.

The required input for C checks will first depend on which modules are included in every check. Each of these will have a maintenance planning document (MPD) estimate to complete routine inspections. These are generally regarded as being low, since they assume perfect conditions. A multiplication factor of three to five is used to get actual routine MH.

"The routine MH required for the C checks are highly variable because of the different modules used. The total is about 1,050 for the C1/3/5/7, about 1,800-2,040 for the C2/6, and 4,100-4,650 and C4/8," says Cooper at Shannon. The C4/8 checks are heaviest because of the CPCP items.

The amount of non-routine MH is then determined by the ratio of non-routine to routine MH, which is influenced by the quality of previous work on the aircraft, depth of the check, environment that the aircraft operates in and age.

"The ratio of non-routine starts at about 0.4 for C1 checks, increases to about 0.5 for the C2 and C3 checks and rises to 0.8 for the C4," explains Cooper. "It falls again to about 0.5 for the C5 and slowly rises to 0.6 for the C6 and C7 and then to 0.9 for the C8. By the time the C12 is reached the ratio has climbed to in excess of 1.1".

Gulf Air, which operates 3.0FH cycles and operates in a corrosive environment, experiences a higher non-routine ratio. "This starts at about 0.9 for the C3 check and rises to 1.1-1.3 thereafter," explains Ousamma Salah, head of planning at Gamco. This would then take total MH for the C3 check to about 2,800, and to 18,000 for the C4 check.

Extra MH will be required in additions to complete docking and aircraft handling, technical cleaning, implement modifications and service bulletins (SBs), interior refurbishment and stripping and painting.

"A budget of about 50MH should be allowed for docking and handling," says Cooper. "The number of MH for technical cleaning is about 200-300 for most C checks, although it is higher for the heavier C4/8 checks, which climbs to 500-600MH.

"The majority of SBs and modifications are dealt with in the C4 check and every fourth repeat. About 1,000MH can be used in these checks for SBs and modifications," explains Cooper. "The other lighter C checks use 400-500MH. The main SBs for the 767 are the engine pylon improvement".

*The 767's maintenance schedule is modular, making check planning complex and many airlines find it hard to achieve high utilisation of check intervals. Despite this, the 767 has low manhour input and non-routine ratio. Heavy checks therefore consume few manhours compared with older generation widebodies, such as the DC-10-30.*

Cabin refurbishment is done every 5-6 years or fourth C check, which most operators treat as being similar to the D check. "Cabin work will include refurbishment of lavatories and galleys; repainting and recovering sidewall panels; cleaning, inspecting and recovering of seats; carpet replacement, and refurbishment of overhead bins. This usually consumes about 3,000MH.

The final element of the C4 check is stripping and painting. Cooper says operators should expect to use 3,000-4,000MH, depending on the paint scheme's complexity.

MH totals for all these elements is 2,100-2,300 for C1/4/5/7, 3,450 for the C2, 4,000 for the C6, about 15,500 for the C4 and 16,600 for the C8 *(see table, page 35)*. The total will climb to about 20,000 for the C12 check, because of higher CPCP content and non-routine ratio. Considering the 767's size these totals are small.

## Materials & consumables

The cost of materials and consumables used during airframe checks is often related to the MH used. Third-party maintenance facilities often quote materials and consumables on a ratio of a set rate of $ per MH used. These items are for parts with a list price of less than $1,000.

A guide to ratios of consumables and materials is $15 per MH for A checks, $20 per MH for lesser C checks and $25 per MH for C4/S4C and C8/S8C checks.

This equates to a cost of $8,250 for A checks, $42,400-80,300 for lesser C checks and $390,000-416,000 for C4/8 checks.

## Check costs

The total cost of A and C checks are summarised *(see table, page 35)*. These are based on an MH rate of $50.

The amortised cost per FH of these checks is determined by the utilisation of check interval achieved. It has been assumed the A check interval of 425FH is achieved.

The 12 A checks in the cycle will therefore be completed once every 5,100FH. The A check with a S1A check will be performed every second and fourth check. The average A check cost per FH is about $87 for aircraft with 4.0FH and 8.0FH cycles.

It is assumed a 4,000FH interval is achieved for aircraft with a 4.0FH cycle, which has a maximum possible interval of 4,500FH between C checks. Aircraft with an 8.0FH cycle will achieve about 5,100FH between C checks.

Because C checks vary in cost, the amortised cost per FH for every interval varies. The average cost for the C checks over the interval is $106 and $83 for aircraft operating 4.0FH and 8.0FH cycles *(see table, page 35)*

## Line maintenance

Lighter line checks for the 767 are transit checks (every flight), daily checks, service checks performed every 125FH and a pre-departure check; they are also performed prior to every departure with the transit check.

These checks will require available labour at an airline's base and line stations. The labour used per check and per aircraft will depend on the other aircraft types line mechanics can service. Labour per aircraft will also be determined by the complexity of an airline's operation, route network and fleet size.

A reasonable cost assumption for line maintenance labour from an operator with half its flights originating at its base and the remainder from outstations, would be $200 per FC. This would result in an FH cost of $50 and $25 for the two FH : FC ratios.

Consumable materials used will be lubricants, engine oil and nitrogen. An appropriate allowance would be $124 per FC for a 4.0FH cycle and $140 per FC for a 8.0FH cycle.

Together the costs will total $81and $42 per FC for 4.0FH and 8.0FH cycles *(see table, page 35)*.

## Heavy components

These components have removal and repair intervals based on FC intervals. Costs per FH therefore depend on the aircraft's operating FH : FC ratio.

Aircraft analysed here with 4.0FH and 8.0FH cycles will have costs per FC divided by the appropriate FH length.

Wheels, brakes and tyres are inter-related. Wheels and tyres are removed together when tyre treads have worn (90% of removals) or have deep cuts (10% of removals).

The FC intervals between tyre and wheel removals are therefore the same. "The nosewheel tyre has a life of about 300FC between remoulds, and the mainwheel tyres about 250FC," explains Robbert van Rees, manager business development components at KLM Engineering & Maintenance. "Nose wheels are remoulded about eight times and main wheels four or five times".

The cost of component repairs and new units are generic third-party costs.

The cost of remoulding nose and main wheel tyres is $180 and $235. The total cost of remoulding all tyres, before replacement, is about $10,400.

New nose and main tyres have a cost of $530 and $1,000. These are replaced every 2,700FC and 1,250FC. Replacement cost for the tyre shipset costs $9,000.

Amortising remoulding costs over the complete life of the tyres is equal to $7 per FC; $2 and $1 per FH aircraft operating 4.0FH and 8.0FH cycles. The cost of new tyres over their life is another $7 per FC; again $2 and $1 per FH *(see table, page 35)*.

Wheel rims are removed with tyres about every 250FC, and then inspected. "We do non-destructive testing (NDT) on the wheel rim and bolts when they are removed," says van Rees. "Every 1,000FC, the rims have to be overhauled anyway, so this would be every third or fourth removal". Wheel rims might be replaced every eight years, or 5,000FC.

The NDT and overhaul cost for each rim is $300 and $400.

Wheel rims are therefore inspected about 15 times during their 5,000FC life and overhauled four times, before replacement. Over the life, amortised inspection costs for all 10 wheel rims are $9 per FC; $2 and $1 per FH. Overhaul costs are $3 per FC; $1 and $0.5 per FH *(see table, page 35)*.

New nose wheel rims cost $5,500 and main wheel rims $11,800. The total replacement cost for a shipset is about $105,000, and equates to a cost of $21 per FC; $5 and $3 per FH *(see table, page 35)*.

"Brakes are carbon. Only main wheels have brakes. "Our carbon brakes have a repair interval of about 2,000FC," says van Rees.

Repair cost is about $30,000 per unit. They are often overhauled every second removal, at a cost of $35,000**.**

Brake repair and overhaul costs for the shipset are $240,000 and $280,000**.** These are amortised over the 4,000FC repair and overhaul cycle. Repair costs are $60 per FC; $15 and $8 per FH. Overhaul costs are $70 per FC; $18 and $9 per FH *(see table, page 35)*.

A brake unit has no fixed life, but average life at KLM is 15 years. A 4,000FC overhaul cycle and annual utilisation of 500-700FC means units are only likely to need replacing once in an aircraft's lifetime. A new unit costs about $36,000, and a new shipset about $290,000. Over a 25-year life, this equals about $12,000 per year, or $20 per FC; $5 and $3 per FH *(see table, page 35)*.

Like most aircraft, the 767's landing gear has a fixed interval. "We have a limit of 12,000FC or 96 months, which is less than the MPD limits," says van Rees.

At annual utilisations of 3,000FH and 5,000FH this is equal to 24,000FH or 40,000FH. The gear has a scrap life of 50,000FC, but this is unlikely to be reached in the aircraft's life.

Most airlines now elect for a gear exchange programme, rather than repairing their own. The cost of an exchange will contain two elements. The first will be an exchange fee, which will cover the cost of ownership. The second will be the repair cost. Total cost for exchange fee and overhaul is about $300,000. This equates to $13 per FH and $8 per FH *(see table, page 35)*.

Thrust reversers do not have a fixed overhaul interval and require sampling, like the landing gear. The original interval has been extended. KLM gets a repair interval of about 6,000FC. Each unit has a repair cost of about $160,000. This equates to $53 per FC for both units; $13 and $7 per FH *(see table, page 35)*.

The APU is also maintained on-condition. The unit, a GTCP 331-200ER, has an average time between shop visits of 6,000 APU hours. An average shop visit costs $150,000. Aircraft will typically run their APUs between flights and for about 15 minutes during taxi. Downtimes will be 1.5-2.5 hours. Aircraft operating 4.0FH and 8.0FH cycles will therefore accumulate

**PASSENGER 767-200/-300 FLIGHT HOUR (FH) AIRFRAME AND COMPONENT MAINTENANCE COSTS**

| Maintenance Item | Maintenance interval | MH used | MH cost ($) | Materials cost ($) | Total cost ($) | Cost per FH ($) 4.0FH cycle | Cost per FH ($) 8.0FH cycle |
|---|---|---|---|---|---|---|---|
| Transit & pre-flight | Every cycle | | | | | | |
| Daily | 24 hours | | | | | | |
| Service | 125FH | | | | | | |
| Total | | 75/week | 3,000 | 6,000 | 9,000 | 150 | 90 |
| System A check | 425 FH | 550 | 27,500 | 8,250 | 35,750 | | |
| System A check plus structural A check | 425 FH | 590 | 29,500 | 9,000 | 38,500 | 87 | 87 |
| C1 check | 4,000/5,100 | 2,120 | 106,000 | 42,400 | 148,400 | 37 | 29 |
| C2 check | 8,000/10,200 | 3,450 | 172,500 | 69,000 | 214,500 | 54 | 42 |
| C3 check | 12,000/15,300 | 2,365 | 118,250 | 47,300 | 165,550 | 42 | 32 |
| C4 check | 16,000/20,400 | 15,521 | 776,000 | 388,000 | 1,164,000 | 291 | 228 |
| Average C check | 4,000/5,100 | | | | | 106 | 83 |
| Landing gear change | 8 years | 700 | 35,000 | | 35,000 | 2 | 1 |
| Engine change | 6,000 FH | 250 | 12,500 | | 12,500 | 2 | 2 |
| **Heavy components** | | | | | | | |
| Tyre remould | 300/250FC | | | | 10,400 | 2 | 1 |
| Tyre replace | 2,400/1,000 | | | | 9,000 | 2 | 1 |
| Wheel rim inspection | 250 FC | | | | 45,000 | 2 | 1 |
| Wheel rim overhaul | 1,000 FC | | | | 16,000 | 1 | 0.5 |
| Wheel rim replace | 8 years | | | | 105,000 | 5 | 3 |
| Brake repair | 2,000 FC | | | | 240,000 | 15 | 8 |
| Brake overhaul | 4,000 FC | | | | 280,000 | 18 | 9 |
| Brake replace | Unlikely | | | | | | |
| Landing gear exchange & repair | 8 years | | | | 300,000 | 13 | 8 |
| Thrust reverser repair | 6,000 FC | | | | 320,000 | 13 | 7 |
| APU shop visit | 10,000 APU hours | | | | 150,000 | 22 | 15 |
| **LRUs/Rotables** | | | | | | | |
| Lease rate | | | | | | 48 | 29 |
| Fixed FH repair cost | | | | | | 180 | 180 |
| **Tot al cost per flight hour** | | | | | | **668** | **526** |

about 1,500 and 1,700 APU hours per year, or an APU shop visit once every 6-7 years.

KLM has negotiated a fixed rate per FH of about $22. Airlines with longer FCs of, say, 8.0FH, might be able to get a rate of about $15 per FH.

## LRUs & rotables

Unlike most types, rotables normally removed during heavy checks are maintained on-condition on the 767. This is the same for line replaceable units (LRUs), and the two groups of components are assessed together.

These components can be owned, managed and repaired by an airline's inventory department.

Operators have access to a number of third-party suppliers. LRU and rotable provision deals are normally structured so that airlines have a base pool of their own stock, which they lease. The cost per FH will then depend on the size of the fleet and therefore stock required and aircraft utilisation. Larger fleets gain from economies of scale, and each aircraft requires a smaller share of the inventory.

Airlines will also require access to another pool of stock of items that fail or require repair at a low frequency, and that is paid for by a fixed access fee per FH.

Repairs for both groups of items can be arranged as a fixed cost per FH. The total cost for these components can therefore be made predictable.

Total inventory for a fleet of five aircraft would cost about $20 million. This will increase with more aircraft, but not proportionately.

The monthly lease rate would be in the region of 1.0% per month. A fleet of five aircraft would then have an annual cost of $2.4 million. This equates to $160 and $96 per FH for the two levels of utilisation.

Fixed rate repair costs would be about $250 per FH. Total costs would then be $410 and $350 per FH.

## Summary

For its size the 767 has low maintenance charges. This is explained by several factors.

The first is that the 767 is generally used on long sectors, which dilutes many line check and component costs. This is illustrated by the difference of $166 per FH between aircraft operating 4.0FH and 8.0FH cycles.

The 767 also has low MH inputs for checks compared to the DC-10-30. This is partially due to the structure of the 767's maintenance programme, which avoids heavy D checks. It is the average cost per FH of the C checks where the largest difference lies between the 767 and DC-10, which consumes proportionately more MH per seat for C and D checks.

Later technology and on-condition philosophy means scheduled rotable repairs are also avoided and avionics are more reliable and so more economic.