Maintenance costs are one of four important operating cost elements, and so influence fleet planning decisions. The maintenance costs of the A300B4, A300-600, A310, 767-200 & 767-300 are analysed here for express package and general freight operations.

Widebody twin freighter maintenance costs

Freight carriers can now choose from several medium widebody freighters when making their fleet selections. While payload capacity and operating performance are important selection criteria, cash operating costs are another consideration. Maintenance costs are an important cash operating cost category, and are considered here for the A300B4, A300-600, A310, 767-200 and 767-300 freighters.

Total aircraft maintenance costs include: line and light maintenance; base checks and interior maintenance; engine maintenance; and components and rotables. The costs for each of these per flight hour (FH) are influenced by average flight cycle (FC) time, annual rate of utilisation, area and style of operation, and age of the aircraft.

Freighters in operation

There are 66 A300B4/C4s, 140 A300-600s, 74 A310-300s, 54 767-200s, and 49 767-300s freighters in operation.

These aircraft are used for express package and general freight services. In each of the A300-600 and 767-300 fleets there are both factory-built and older passenger-converted aircraft. The A300B4, A310 and 767-200 fleets are all converted aircraft. The number of converted A300-600, A310 and 767 freighters is increasing as used passenger aircraft become available.

Express package operations have low rates of utilisation where the aircraft are used on short-haul services. Examples are: Astar Air Cargo and European Air Transport, TNT and Tradewinds in the A300B4 fleet; FedEx and UPS in the A300-600 fleet; FedEX in the A310 fleet; ABX Air and Star Air and in the 767-200 fleet; and UPS in the 767-300 fleet. With the exception of UPS's 767-300s, all these aircraft are operated at low rates of utilisation: 800-1,600FH in most cases. Average cycle times for the A300B4 are 0.7-1.2FH in many cases, although Tradewinds has longer cycle times of 2.5-3.0FH. FedEx and UPS have FC times of 1.7-2.0FH for their A300-600s and A310s. Star Air of Denmark averages 2.0FH with its 767-200s.

ABX Air, however, manages to achieve medium rates of utilisation of 1,400-2,100FH per year. Its aircraft are operated on medium cycles of 2.5-3.0FH.

The 767-300s operated by UPS are the only express package freighters whose utilisations are in excess of 3,000FH per year. These are used on cycles of 3.0-4.0FH, sometimes on transatlantic routes.

Freighters used for general freight achieve higher rates of utilisation. A300B4s operated by ACT Airlines and MNG Airlines generate up to 2,000FH per year, with FC times of 2.5-3.0FH.

In the case of A300-600s Air Atlanta Icelandic achieves 2,500-3,500FH per year and cycle times of 3.6-4.3FH. THY has similar FH utilisations for its A310s, and operates at 2.8-3.2FH per cycle. Some of the highest rates of utilisation for medium widebody freighters are reached by Latin American carriers, with Tampa Air Cargo achieving 4,000FH per year with its converted 767-200s, and Absa, Florida West and LAN Cargo 5,500FH per year with their factory-built 767-300s. These aircraft are used on medium- and long-haul operations with FC times of 3.0-4.5FH per cycle.

Maintenance analysis

The maintenance costs of the five aircraft types are analysed for express package and general freight operations.

The A300B4, A300-600, A310 and 767-200 are analysed on short-haul services with an average FC time of 1.5FH, and generating 1,200FH and 750FC per year.

The maintenance costs of all five types are analysed in general freight operation. The A300B4s, A300-600s and A310s are examined under short- and medium-haul operations with average FC times of 3.0FH. The A300B4 is examined at utilisations of 2,000FH per year, while the A300-600 and A310 are examined at 2,500FH. The two 767 models, with longer-range capability, are examined at FC times of 4.0FH, generating 4,500FH and 1,100FC per year.

Maintenance programmes

Maintenance programmes for each aircraft are the first step in examining maintenance costs.

The line maintenance programmes are the same for all five types, and similar for most aircraft types generally. While the inputs for each line check are relatively small, the total labour and material expenditure for all annual checks comprises a significant portion of total maintenance cost.

The line maintenance programmes start with a pre-flight check prior to the first flight of each operational day, so about 350 of of these will be required each year. Transit checks are performed prior to each subsequent flight during an operational day. Aircraft on express package operations will require about 400 transit checks per year, while those operating on general freight services will complete 330-750 transit checks per year, depending on annual utilisation.

Daily checks have a larger workscope than pre-flight checks, and are permitted once every 24-48 hours. About 225 of these are required annually. Weekly checks have larger workscopes than daily checks, so 47 or 48 are performed yearly.

The base maintenance programmes of the five aircraft types vary.

A300B4, A300-600, A310 & 767-200/-300 MAINTENANCE PROGRAMMES

Check	Check group tasks	MPD interval
A300B4		
A1/3-month	3-month	500FH & 3 months
A2/6-month	3-month + 6-month	1,000FH & 6 months
A3/9-month	3-month	1,500FH & 9 months
A4/12-month	3-month, 6-month	2,000FH & 12 months
C1/24-month	24-month	4,000FH & 24 months
C2/48-month	24-month & 48-month	8,000FH & 48 months
5-year	60-month CPCP	60 months
C3/72-month	24-month	12,000 & 72 months
C4/96-month	24-month + 48-month + 96-month & 9-year CPCP	16,000FH & 96 months
A300-600 & A310		
A1	1A	400FH
A2	1A + 2A	800FH
A3	1A	1,200FH
A4	1A + 2+ 4A	1,600FH
A5	1A	2,000FH
A6	1A + 2A	2,400FH
A7	1A	2,800FH
A7	1A +2A +4A +8A	3,200FH
C1	1C	15 months
C2	1C + 2C	30 months
C3	1C	45 months
C4	1C + 2C + 4C + 5-year	60 months
C5	1C	75 months
C6	1C + 2C	90 months
C7	1C	105 months
C8	1C + 2C + 4C +8C +10-year	120 months
767-200/-300		
A1	1A	500FH
A2	1A + 2A	1,000FH
A3	1A + 3A	1,500FH
A4	1A + 2A + 4A	2,000FH
A5	1A	2,500FH
A6	1A + 2A + 3A + 6A	3,000FH
A7	1A	3,500FH
A8	1A + 2A + 4A	4,000FH
A9	1A + 3A	4,500FH
A10	1A + 2A	5,000FH
A11	1A	5,500FH
A12	1A + 2A + 3A + 4A + 6A	6,000FH
C1/5/9	1C + S1C	6,000FH/3,000FC/18 months
C2/6/10	1C + S1C + 2C +S2C	12,000FH/6,000FC/36 months
C3/7/11	1C + S1C + 3C + S3C	18,000FH/9,000FC/54 months
C4/12	1C + S1C 2C + S2C + 4C + S4C	24,000FH/12,000FC/72 months
C8	1C + S1C 2C + S2C + 4C + S4C + S8C	48,000FH/24,000FC/144 months

A300B4

The A300B4 is the oldest of the five types. The basic structure of the Airbus base maintenance programme was a cycle of A checks, with four multiples and eight checks. The A300B4's maintenance planning document (MPD) has had its 27th revision. The basic A check interval is 250FH. The interval between each check was originally 12 months when the A300B2/4 entered service, and has since been changed to a utilisation interval of 2,500FH, with no calendar limits. This maintenance programme is therefore used for both types of operation used here.

A maintenance programme for aircraft operating at less than 2,000FH per year has also been developed. The A check intervals are 500FH or three months, whichever is reached first. There is a cycle of eight checks, so the eighth check is at 4,000FH. The C check interval is 4,000FH or 24 months, whichever is reached first; the same as the eighth A check. The 24-month check has replaced the C check. There are multiples of this 24-month check so that the cycle has four checks at 48, 72 and 96 months *(see table, this page)*. The 96-month check is the heaviest. "There also used to be 30-month corrosion prevention and control programme (CPCP) tasks, but these have been included in the 24-month check by most operators," explains Ugur Kalkan, technical director at MNG Airlines. "There are also 60-month CPCP tasks, and nine-year CPCP tasks. We perform the 60-month tasks as a separate check, but incorporate the nine-year tasks in the 96-month check.

"There is also a supplemental structural inspection document (SSID), which was changed to a group of tasks known as the airworthiness limitation items (ALI) in 2006. The SSID comprised structural items only, but the ALI tasks now include some additional system inspections," explains Kalkan. "We therefore have a system of four checks we refer to as the C1, C2, C3 and C4 checks. The C1 has the 24-month check and the 30-month CPCP items. The C2 check has the 48-month check. Then there are the 60-month CPCP tasks. The C3 check has the 72-month check, while the C4 check has the 96-month and 9-year CPCP tasks *(see table, this page)*.

The maintenance costs of the A300B4 in both express package and general freight operations are analysed here with the low utilisation programme.

A300-600 & A310

The A300-600 and A310 have a maintenance programme that had an original basic A check interval of 400FH. There are also multiples of these tasks, and a complete cycle of eight checks.

The base maintenance programme is a system of eight base checks, with the fourth and eighth checks being heavy. The basic C check interval is 15 months, with the eighth check having an interval of 120 months. The revisions of the MPD have taken this interval up to 18 months. There are also structural inspections and CPCP tasks with intervals of 60 and 120 months. These are combined with the C4 and C8 checks, so the two heavy checks have intervals of 60 and 120 months. The contents of the eight checks are summarised *(see table, this page)*.

The A300B4 has the disadvantage of high engine-related maintenance costs relative to its younger counterparts. The A300B4 also has higher fuel burn and flightcrew charges.

There have been 24 revisions to the MPD. The original A check interval was 400FH, and after three revisions the interval is now at 600FH. The basic C check interval has been escalated to 18 months, so the 8C tasks have an interval of 144 months, or 12 years. The first set of structural tasks have had their intervals extended to 72 months, but the interval for the second set of tasks is still at 120 months. This means that the C8 check and second structural tasks could potentially be out-of-phase with each other. Most operators are likely to complete their base check maintenance cycles every eight to 10 years.

767-200/-300

The 767-200/-300 were developed with an MPD that grouped system and structural and CPCP tasks separately into checks with FH and FC intervals.

The basic system A check tasks have an MPD interval of 500FH, which has been extended by many operators to 600FH. There are 2A, 3A, 4A and 6A multiples, with the A check cycle finishing at the A12 check that has an interval of 6,000FH.

The basic structural tasks, the S1A, have an interval of 300FC, and there is also a group of S5A tasks at 1,500FC. The grouping of the A check tasks is summarised *(see table, page 80)*.

The basic system C check tasks have an interval of 6,000FH and 18 months, whichever is reached first. There are 2C, 3C and 4C multiples with corresponding FH and calendar intervals up to 24,000FH.

The basic structural C check tasks have an interval of 3,000FC, and there are S2C, S3C and S4C multiples with corresponding intervals up to 12,000FC. The 1C and S1C tasks are usually combined together in one check.

The fourth check in the cycle, the C4, is the heaviest with an interval of 24,000FH and 72 months. In reality operators actually achieve an interval of 60-66 months. The arrangement of these tasks into C checks is summarised *(see table, page 80)*. While the C and SC tasks repeat at the relevant intervals, the CPCP schedule of tasks is more complicated and increases as the aircraft's age increases. The number of tasks is higher in the second base check cycle than the first, and also higher in the third cycle than in the second. Most 767s will be converted to freighters at an age of 15 years of more, so they will be in their third or fourth base maintenance cycles.

Line & light checks

The four types of line check have been described. Pre-flight and transit checks are more commonly performed by flightcrew to save labour cost of line mechanics. Even though these checks consume few man-hours (MH), the number performed each year means that the annual cost of these checks can be up to $100,000 per aircraft.

It is assumed here that pre-flight and transit checks are performed by line mechanics. The pre-flight check consumes an average of 1.5MH and about $10 for materials and consumables, while a transit check on average will consume 1.0MH and $5 of materials and consumables.

Daily checks will consume about 3.5MH and $35 in materials, while larger weekly checks will use an average of 8.0MH and $50 of materials.

Taking into consideration these inputs, a labour rate of $70 per MH, the aircraft's annual utilisation, and the number of different line checks performed each year, the total cost of line checks per FH can be reached *(see tables, page 84)*.

This is in the region of $135 per FH for the four types operating express package services, assuming these aircraft have little difference in MH and material inputs for their different line checks.

The cost per FH for line checks reduces as average FC time and aircraft utilisation increase with general freight operations. The A300B4 therefore has a cost of about $80 per FH, while the A300-600 and A310 have a cost of about $70 per FH. The 767-200s and -300s, operating longer cycles and at higher rates of utilisation, have costs of about $45 per FH *(see second table, page 84)*.

The content of A checks includes routine inspections, some engineering orders (EOs) and service bulletins (SBs), a small amount of interior work, and non-routine rectifications. The total labour content for the three-month checks on the A300B4 will average 1,100MH, and expenditure on materials and consumables will be $15,000.

The younger A300-600, A310 and 767-200/-300 will use 700-800MH and $10,000-13,000 for A checks.

Using the same labour rate of $70 per MH, the cost per FH for these checks will be about $307 for the A300B4 because only about 300FH are accumulated every three months when operated on express package services. The A300-600, A310 and 767-200/-300 will have costs of $125 per FH for the A checks *(see first table, page 84)*.

Costs per FH are lower when aircraft are used on general freight operations. Costs for the A300B4 are about $185 per FH, and lower at $125-130 per FH for the other four types *(see second table, page 84)*.

Base checks

The inputs and reserves for base checks account for one of the largest elements of all maintenance costs. The content of these checks includes: routine inspections; CPCP inspections in some cases; modifications, ADs and EOs;

Most A300-600 freighters are factory-built, rather than converted aircraft. The A300-600 and A310 have shorter range than their 767 counterparts. As a consequence, the A300-600 and A310 are likely to be used on shorter routes and achieve lower rates of utilisation.

component tests and changes; interior work; and non-routine rectifications that arise. The amount of interior work will be smaller than on passenger-configured aircraft. While passenger equipment will be absent and so save refurbishment costs, cargo loading and handling systems can often require a lot of MH. Operators may also include stripping and painting, but will do this less frequently than on passenger aircraft to save costs.

A300B4

As described, the A300B4 has a system of four 24-month checks, plus several CPCP packages and ALI items.

Kalkan explains the C1 and C3 checks are virtually the same in content and consequently labour and material cost inputs. MNG's aircraft are 23-33 years old and have been through their second D checks. They are now in their third base check cycle. C1 and C3 checks consume a total of 10,000MH and up to $40,000 in materials and consumables. "There may also be a few out-of-phase structural tasks, which can add to the workscope," adds Kalkan. The C2 check is heavier and uses an average of 14,000MH and $70,000 in materials.

The five-year check will use 5,000MH and $30,000 of materials. The C4 check, with the nine-year CPCP tasks, uses up to 20,000MH and $300,000 of materials and consumables. The biggest saving in these base checks compared to passenger-configured aircraft is the use of materials and consumables in the heavy checks, with freight aircraft using less because of the absence of a passenger interior.

The total consumption for the five checks over the cycle is 55,000MH and $450,000-500,000 in materials. At a base labour rate of $50 per MH, the total cost for the checks is about $3.5 million.

A300-600 & A310

Of the eight checks in the base cycle for the A300-600 and A310, the C4 and C8 are heavy and the other six relatively light. The routine tasks in the six lighter C checks each use about 1,500MH. Other items such as EOs, out-of-phase tasks, and component changes can use another 900MH. There will also be some interior work, although this will be minimal and mainly relate to the cargo loading system. It may use 200-300MH. The non-routine rectifications arising from these elements will be 700MH for a medium-aged aircraft, but are likely to increase to more than 1,000MH as aircraft age. The total for these lighter checks will be 3,500-4,000MH. Materials and consumables will cost $20,000-30,000.

The C4 check will use 13,000MH for routine tasks, 4,000-5,000 for other items and from 7,000MH for non-routine rectifications. This takes the total to 18,000-20,000MH. Cost of materials and consumables is $300,000-350,000.

The C8 check is heavier, with all groups of tasks requiring 15-20% more MH, and the total labour requirement for the check reaching 22,000-24,000MH and about $400,000 of materials and consumables. As with other aircraft types, freighter variants of the A300-600 and A310 have lower consumption of materials and consumables compared to passenger-configured aircraft.

The total inputs for the eight checks in the cycle is 63,000-65,000MH and $900,000 of materials and consumables, taking the total to $4.0-4.2 million.

767-200/-300

The four checks in the 767's base check cycle include two light C1 and C3 checks. The C2 check has an intermediate workscope, with the C4 being the largest check with up to four times the content of the C1 and C3 checks.

The two light checks use 1,500-2,000MH for routine tasks, another 900MH for EOs, out-of-phase tasks and component changes and 500-750MH for interior work. The sub-total for these items is 3,000-3,700MH. Non-routine rectifications will be 70% or 2400-2,700MH for aircraft in the second base check cycle, but will rise to 100% and more once aircraft are into their third and fourth base check cycles. This will take total labour up to 7,500MH for these lighter checks. Cost of materials and consumables will be up to $50,000.

The intermediate C2 check will use about 3,500MH for routine inspections and 1,500-1,800MH for other items. Non-routine rectifications will take the total for the check to 8,500-10,000MH. Commensurate cost of materials and consumables will be $60,000-70,000.

The heavy C4 check will use 8,000-9,000MH for routine tasks, depending on aircraft age. Another 1,500MH for other items, and up to 3,000MH for interior work will take the sub-total to 12,500-13,500MH. Non-routine rectifications will add another 10,000-13,000MH depending on age and base check cycle taking the total for the check to 22,000-26,000MH. Cost of materials and consumables will be $350,000-400,000.

The total inputs for the four checks in the cycle will be 40,000-45,000MH and $500,000-550,000 of materials and consumables. A labour rate of $50 per MH will take total cost for the four checks to $2.7-2.9 million.

Base check reserves

The reserves for these checks will mainly be influenced by the rate of aircraft utilisation. The non-routine ratio for the base checks will depend partly on the rate of aircraft utilisation. The amount of labour used on non-routine rectifications will generally be lower for aircraft used on express package services which operate at lower rates of utilisation compared to aircraft that achieve more FH per year and between checks. Aircraft

While the 767-200 has long-range performance it has lower freight capacity than the larger -300 variant. Most freight carriers are waiting for the availability of used -300s to increase and their values reduce before acquiring them for conversion.

operating at higher rates of utilisation will not use a proportionately higher number of MH for checks in relation to FH achieved between checks. Aircraft used for general freight services, therefore, will have lower reserves per FH for base checks.

The A300B4 on express package operations will have intervals of 2,400FH between C checks, and will complete its cycle of four checks every 9,500FH. The total cost for the checks will therefore be equal to a reserve of $360 per FH *(see first table, page 84).*

The A300-600 and A310 will have a C check every 1,500FH, and complete the cycle of eight base checks every 12,000FH. The $4 million cost of the eight checks translates into a reserve of $335 per FH *(see first table, page 84).*

The 767-200 in its third base check cycle is likely to use 45,000MH and $550,000 of materials in its cycle of four checks, at a total cost of $2.8 million. The aircraft will achieve 1,800FH between checks, and so will have a base maintenance reserve of $350 per FH *(see first table, page 84).*

Total costs incurred for base check cycles will be marginally higher on general freight operations compared to the cost of checks for aircraft used on express package operations, as described. The A300B4's annual utilisation of 2,000FH means the interval between C checks is about 4,000FH, and the cycle of base checks is completed every 16,000FH. This results in a reserve of $216 per FH *(see second table, page 84).*

The A300-600 and A310 have check intervals of 3,100FH, and complete the full cycle of eight checks every 25,000FH. This results in a reserve of $161 per FH *(see second table, page 84).*

The 767-200 and -300 operating at the highest rates of utilisation of 4,500FH per year will achieve 6,800FH between C checks and accumulate 27,000FH over the full cycle. The full cost of $2.6-2.8 million over this interval will be equal to a reserve of $95-105 per FH *(see second table, page 84).*

Heavy components

Rotable components on the aircraft can be divided into: heavy components, which have maintenance intervals closely related to FCs; and line replaceable units (LRUs), which have more random removal intervals.

The four main heavy component types are: landing gears; wheels and brakes; thrust reversers; and the auxiliary power unit (APU). The heavy components used on the five aircraft types are similar, with all types using derivatives of the same APU, for example. Most components will have similar FC removal intervals and repair and overhaul costs, and so reserves per FC. The exception is the A300B4 and 767, which have steel brakes compared to the A300-600/A310, which have carbon brakes.

The costs per FC and per FH for the aircraft are summarised *(see tables, page 84).* The costs per FH are influenced by annual rate of utilisation and average FC time. The aircraft used on express package services consequently have higher costs per FH.

LRU reserves

Most freight operators should be able to simplify the sourcing, repair and management of LRU rotables by using specialist rotable providers, who supply airlines with homebase stocks of more essential items, access to pools of less essential LRUs, and fixed rate per FH contracts for the repair and management of components.

The costs per FH for the A300-600, A310 and 767-200/-300 are similar, so the capital cost of equipment, as are the repair and test costs of components. The removal intervals for LRUs on the A300B4 will be shorter than for other types, however. The repair costs of the A300B4's components will also be higher.

The overall cost per FH for each aircraft type will also be influenced by annual rate of utilisation and average FC time. The costs for the A300B4 are the equivalent of $350-400 per FH for the two types of operation *(see tables, page 84).*

The costs per FH for the A300-600, A310 and 767-200/-300 will be $300 per FH for express package operations *(see first table, page 84).* This rate will fall to $230-250 per FH for general freight operations *(see second table, page 84).*

Engine maintenance

Engine reserves per engine flight hour (EFH) are dependent on engine type and average engine flight cycle (EFC) time. The A300B4 is analysed here with CF6-50C2 engines, while the CF6-80C2A5/A1 are used for the A300-600 and A310.

Younger and higher gross weight 767-200s are equipped with CF6-80C2B4 engines, and many of the 767-300ERs that are likely to be converted will have the same variants or PW4060/62 engines.

The CF6-50C2 of the A300B4 is sensitive to short-cycle operations, and the engine will have removal intervals of 2,000-2,200EFC. At an average EFC time of 1.5EFC, this is equal to 3,300EFH. Removal intervals will be 5,500-6,000EFH for engines operating at 3.0EFH per EFC.

Shop visit costs for the CF6-50C2 are $1.4-1.8 million, depending on workscope. This would result in reserves of $800 per EFC for shop visit work. Most life limited parts (LLPs) have lives of 20,000-30,000EFC, and a full shipset has a list price of $2.0 million. LLP reserves would be $80-90 per EFC. This takes total reserves up to $900 per EFC, which is equal to $600 per EFH for operations at 1.5FH per FC, and $300-350 per EFH for operations at 3.0FH per FC. An additional $17 per EFH should be

SUMMARY OF WIDEBODY FREIGHTER COSTS - EXPRESS PACKAGE OPERATIONS

Aircraft	A300B4	A300-600/ A310	767-200
FH per year	1,200	1,200	1,200
FC per year	750	750	750
FH:FC ratio	1.5	1.5	1.5
	$/FH	$/FH	$/FH
Line & ramp checks	135	135	135
A checks	307	125	125
Base checks	360	335	350
Heavy components	281	294	351
Rotable/LRU components	400	300	300
Engine maintenance	2 X 600	2 X 475-535	2 X 475-535
Engine QEC	2 X 17	2 X 20	2 X 20
Total	**2,720**	**2,180-2,300**	**2,250-2,370**

SUMMARY OF WIDEBODY FREIGHTER COSTS - GENERAL FREIGHT OPERATIONS

Aircraft	A300B4	A300-600/ A310	767-200/ -300
FH per year	2,000	2,500	4,500
FC per year	670	835	1,100
FH:FC ratio	3.0	3.0	4.0
	$/FH	$/FH	$/FH
Line & ramp checks	80	70	45
A checks	184	124	124
Base checks	216	161	95-105
Heavy components	156	153	128
Rotable/LRU components	350	250	250
Engine maintenance	2 X 350	2 X 240-270	2 X 200-250
Engine QEC	2 X 17	2 X 16	2 X 16
Total	**1,640**	**1,270-1,330**	**1,075-1,184**

allowed for quick engine change (QEC) kit repair. Operators may be able to realise some savings, however, by acquiring time-continued engines at values less than the cost of shop visits when market availability of engines is high. This makes it possible to avoid the expense of acquiring a full set of LLPs.

The CF6-80C2 is also sensitive to operations at short cycle times of 1.0-1.5EFH, with intervals of 4,500-5,000EFC. This is equal to 6,700-7,500EFH. While this is better than the CF6-50C2, the -80C2 has higher shop visit costs of $2.3-3.0 million, depending on the workscope. Shop visit reserves will therefore average $550-600 per EFC.

The CF6-80C2 has 20 LLPs, most with lives at 20,000EFC. A full shipset has a list price of $2.8-2.9 million. Reserves for the parts will therefore be $160-195 per EFC. This will take total reserves to $710-800 per EFC. This is equal to $475-535 per EFH at an EFC time of 1.5EFH, $240-270 per EFH at 3.0EFH, and $180-200 per EFH at 4.0EFH. An additional $16-20 per EFH should be added for QEC repair.

The PW4060/62 is an alternative engine for the 767-200 and 767-300. At an EFC time of 4.0EFH, the engine has removal intervals of 3,500EFC. This is equal to 10,000EFH. The PW4060/62 is easy to manage in many cases, and follows an alternating shop visit pattern of a core restoration and full overhaul. These have costs of $1.8-2.3 million and $2.5-2.9 million. Reserves over these two intervals will equal $615-745 per EFC.

The PW4060/62 has 24 LLPs, all with lives of 15,000EFC. A full shipset has a list price of $3.6 million, meaning LLP reserves will be $260 per EFC. Total reserves will therefore reach $875-1,000 per EFC; equal to $220-250 per EFH when operated at 4.0EFH. An additional $16-20 per EFH should be added for QEC repair.

Summary

The A300B4, unsurprisingly, has higher costs in both modes of operation. In the case of express package operations the largest differences between the A300B4 and younger aircraft come from the reserves for A checks and engine maintenance. These two elements are $380 higher for the A300B4 than the other types. The A300B4's total costs are $2,700-2,750 per FH. Engine reserves cost $1,200 per FH, while the costs for the A300-600/A310 and 767 are $2,200-2,370 per FH *(see table, this page)*.

In the case of general freight operations, the A300B4's total costs are $1,640 per FH, which is $310-370 more per FH than the A300-600 and A310. Again, the A300B4's A check and engine reserves are higher than the A300-600's and A310's. The A300B4's maintenance cost disadvantage is also likely to increase as its age and non-routine rectifications rise. "There are three factors that will decide the A300B4's future. These are a mandatory thrust reverser locking system, a frame 47 mandatory inspection that could require a repair, and crack on the rib 5 landing gear attachment," says Kalkan. "We do, however, plan to put the aircraft through its fourth heavy check."

In addition to higher maintenance costs, the A300B4 is also disadvantaged by its higher fuel burn and three-man flight crew. "Flight engineers are becoming harder to employ and add a lot to our total cost of flight crew," adds Kalkan.

The 767-200's and -300's costs at high rates of utilisation and higher average FC times of 4.0FH are $1,075-1,184 per FH *(see table, this page)*. The 767's lower costs are achieved because of the longer FH intervals between checks and the longer FC time which reduces the costs and reserves per FH for all elements of maintenance cost. The two 767 variants further benefit from having higher gross structural payloads than their respective A300-600 and A310 competitors. The 767-200, however, has similar or higher costs than its younger, larger and more capable -300 counterpart. While a small number of more 767-200s may get converted to freighter, most freight operators will wait for the availability of retired 767-300s to increase and convert these. The 767-300 freighter has a unique market position and will be able to fill it economically. AC