Stage 3 hushkits have been certified just in time to save the 707 and DC-8-50/-61. Is there merit in keeping these aircraft in service or are there alternatives to replace the aircraft economically?

Can the 707 and DC-8 justify another life extension programme?

The recent certification of Stage 3 hushkits for the 707 and DC-8-50 and -61 series has raised the issue of whether it is economical to extend their lives once more.

The 707 and DC-8-50/-61 are now operated in small numbers as freighters. The 707 and DC-8 are used by small operators to carry general cargo, sometimes of medium and high packing densities, at generally low yields on long-thin sectors.

Although only a portion of 707s and DC-8s are based in North America and western Europe. However most aircraft fly global routes and so require Stage 3 modification by December 1999 to fly in North America by April 2002 within Europe. Stage 3 compliance is not the only issue. Most 707s and DC-8s will also require avionic modifications to continue operation in many global regions.

While it may be seen as economic folly to spend more on the life extension modification of an aircraft than its possible market value, most 707 and DC-8-50/-61 operators see no alternative because it is generally felt that there are no suitable replacements.

Parameters

The 707 and DC-8 fraternity operate freight routes carrying general cargo which generate low yields and levels of utilisation between 2,000 and 3,500 flight hours (FH) per year. The aircraft are ideal because of their durability and well matched payload capacity and range.

The 707-320C has a structural payload of 94,500lbs. The 707-320C can carry about 86,000lbs up to 3,000nm and about 62,000lbs 4,000nm.

The DC-8-55CF can carry about 80,000lbs 3,000nm and 50,000lbs 4,000nm. The larger DC-8-61CF can only carry 60,000lbs 3,000nm and about 39,000lbs 4,000nm *(see payload-range chart, page 43)*.

Only aircraft with similar payload-range performance to the 707 and DC-8 are possible replacement candidates.

Replacements

The only aircraft to have similar payload-range ability to the 707 and DC-8-50/-61 is the freighter converted A310-300F. The highest gross weight A310-300F has a structural payload of 88,400lbs. This is about 10,000lbs less than the 707-320C and DC-8-55F, but the A310-300F does have longer range.

The A300B4 has enjoyed recent market entry success into the freight sector and has lease rates which are not excessive. The A300B4 however has a maximum packing density in the region of 7.0lbs per cubic foot and so is more suited to the carriage of small packages. This compares to a density of 15-17lbs per cubic foot for the 707-320C and DC-8-55F. The A300B4 also has shorter range than the 707 and DC-8.

The payload-range chart clearly shows that the A310-300F can outperform the 707 and DC-8 with smaller loads, and present itself as a viable alternative aircraft in this respect. The A310-300F is still a weak candidate in several respects. The first is that most operators would prefer to replace their existing aircraft with a higher capacity aircraft capable of accommodating growth in their freight business.

Performance

When considering containerised freight loads, the 707 and DC-8 use 125 inch wide by 88 inch long pallets. The 707 and DC-8-50 each accommodate 13, while the DC-8-60 can carry 18 pallets.

The A310 can accommodate two rows of eight 88 inch wide by 125 inch long containers known as AAX containers. These are higher and about 95lbs heavier than AAC containers and have an internal volume of 500 cubic feet. The A310 can take 14 LD-3 containers in its lower hold. The container weights and volumes these configurations allow are summarised in the table (*see page 45*).

The tare weight of the containers means the 707 and DC-8-55 have net structural payloads of about 92,000lbs, with the A310-300 at about 16,000lbs less. The A310's heavy maindeck container tare weight results in a large loss of net payload.

The A310's configuration also means its maximum packing density is about 8.0lbs per cubic foot lower than the 707 and DC-8-50. This means at high packing densities the A310 will use only about half of its container volume. Like the A300B4, the A310 is most suited to carrying small packages rather than the

heavier materials normally carried by the 707 and DC-8.

When comparing the 707, DC-8-55F and A310-300F with gross structural payloads of up to 85,000lbs on a sector length of 3,000nm, the net structural load of each aircraft varies between 74,000lbs and 82,000lbs. An operating cost comparison should be made on the basis of costs per lb of these net payloads. This will put the A310 at a disadvantage because it has the lowest net payload.

Hushkits

Burbank Aeronautical has received certification for its Stage 3 hushkit for the 707. The kit means the aircraft has no operating weight or altitude restrictions and the aircraft's fuel burn is the same as the un-hushkitted Stage 1 aircraft. This compares to the 10% fuel burn penalty imposed by the Stage 2 hushkit, which will be recovered when the new kits are fitted.

The only penalty the kit imposes on the aircraft is a hull weight addition of 2,900lbs. This impact on payload is partially compensated by the improvement in range through reduction in fuel burn. The 1999 list price for the kit is $3 million per shipset. Burbank is also developing a winglet for the 707. At a list price of $400,000 this achieves another fuel burn reduction of 7%. The hushkit and winglet achieve a corresponding increase in range of 500nm. An aircraft with the hushkit alone would have its range extended to about 3,300nm with a 86,000lbs payload.

Burbank is also planning to develop the kit to be certified on the DC-8-50/-61. The number of remaining aircraft is small however and Quiet Technology Venture (QTV) has already created its own kit for these aircraft.

QTV is a result of company restructuring by QNC (Quiet Nacelle Corporation). Like the Burbank 707 kit, the QTV kit for the DC-8 imposes no weight or operation penalties on the aircraft. QTV has found during testing that there is a 4% to 5% fuel burn penalty imposed by the kit, although this can be offset by reducing speed to around Mach 0.80. The kit has a list price of $2.75 million per shipset.

"Despite this the aircraft has an improved fuel burn performance relative to Stage 1 and Stage 2 modified aircraft," claims Martin Gardner, chief engineer at QTV. "We expect to modify about 40 aircraft of the approximately 60 DC-8-50s and -61s still flying. All of the South American aircraft fly into the US, and there are about 45 aircraft based in North and South America. There are also four operators in Europe. Fine Air has already placed an order for 15 of its aircraft and we are negotiating with three other US airlines which have about 22 aircraft. If two or three operators place orders then we have sold all of 1999's production capacity."

707 and DC-8

Continued operation of the 707 and DC-8 is not as straightforward as hushkitting. Both have several maintenance and technical issues to consider.

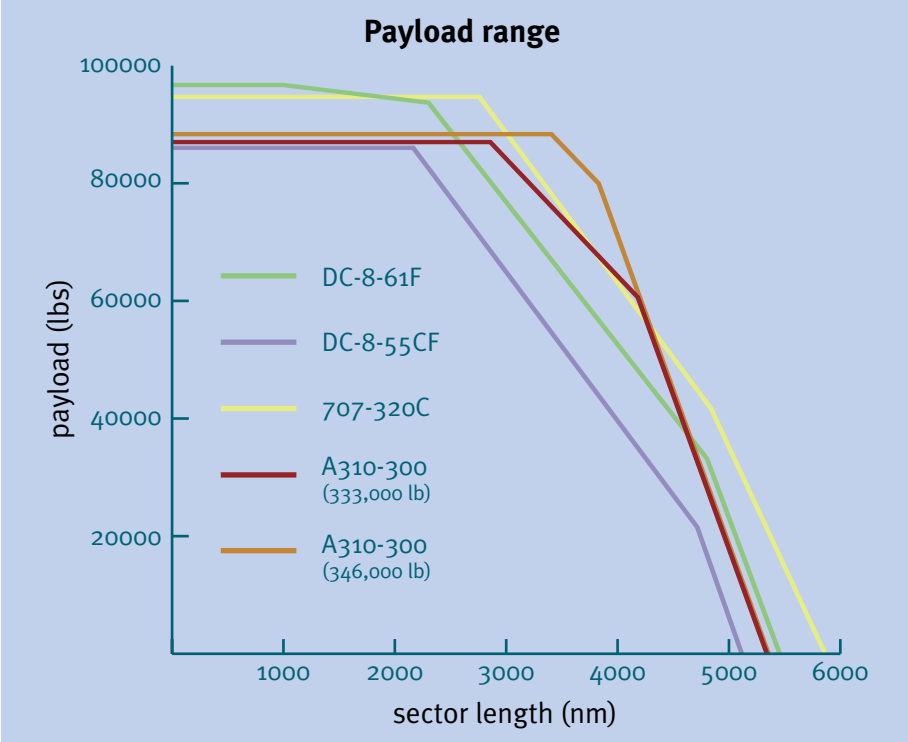
These include structural considerations and items relating to technical support. Other issues include the advances in air traffic control. Reduced vertical separation, for example, requires aircraft to have more accurate autopilots fitted and this will certainly mean new avionics have to be installed in most 707s and DC-8s. TCAS (traffic collision avoidance system) is not required for freighter aircraft, but windshear detection instruments are. Many 707s and DC-8s will also need to have inertial navigation systems, flight management systems and even global positioning systems if trans-Atlantic operations are to continue.

Practical considerations of operation also feature highly in these fleet selections. The DC-8 and 707 are not affected by Etops issues. *(See 'Etops for ultra long-range missions' page 26.)* Switching to the A310 would require airlines to become operationally and technically prepared for long-range twin-engine aircraft operations. This would add further overheads to operating the aircraft.

The DC-8 and 707 are flown to many remote regions in Africa and South America. Despite their vintage there is still extensive technical and operational support for these aircraft, whereas support for the marginally successful A310 is limited to a small number of specialist suppliers and operators in Europe and North America. Again, if DC-8 and 707 operators elected or were forced into A310 acquisitions then they would incur increases in costs of operating the aircraft.

Despite the availability of hushkits there is still a noise issue surrounding the 707 and DC-8. The international civil aviation organisation (ICAO) recently voted against a non-addition rule for Stage 3 modified aircraft. That is, in regions where Stage 3 compliance becomes mandatory a non-addition rule would prevent Stage 3 modified aircraft being imported into fleets, despite complying with noise regulations. "The European Commission (EC) may still implement a non-addition rule even though ICAO says the EC would not be acting unilaterally," says Captain Mike Kruger, managing director of UK DC-8 operator MK Airlines.

Non-addition rules are seen as political hurdles to extending used aircraft lives. "Although a non-addition rule would not prevent us from operating our DC-8s if we hushkitted them, it would still impact negatively on our aircraft re-sale and security values," explains Kruger. This would make the financing of existing aircraft less tenable. Not surprisingly European DC-8 and 707 operators are sceptical about the EC's attempts to enforce a non-addition rule, and feel it is unnecessary when there are such a small number of 707s and DC-8s still in service.



Economics

Besides the practical considerations of operation, sustained economic viability is the key issue. Besides aircraft finance charges, airlines will consider fuel, maintenance, flight crew, insurance and user charges.

The very similar gross weights will mean hushkitted 707s and DC-8s should have very close airport landing and navigation fees to the A310-300F. These costs become insignificant in areas where user fees are low.

Fuel burns of the 707-320C and DC-8-55CF are similar. For a 3,000nm sector the 707-320C is not payload restricted and will burn 14,778 US gallons with a 85,000lbs gross payload. The DC-8-55CF is payload restricted and can only carry 81,750lbs and burns 14,900 US gallons. The A310 is not payload restricted at 3,000nm, and with a 85,000lbs gross payload burns 10,280 US gallons.

The fuel cost at 65 cents per US gallon with these payloads are shown in the table *(see page 46)*.

Maintenance costs are a major consideration. The 707 is a less durable airframe than the DC-8, however the attraction of both aircraft is the simplicity of their avionics and components. These are mostly cheaper than their modern counterparts on aircraft such as the A310.

Most operators' maintenance programmes conform to the original maintenance planning document. A system of A, B and C checks are performed about every 150 FH (40-60 days) 750 FH (128 days) and 3,000FH (18-20 months).

Landing gear changes are made every 10 years and have an approximate exchange fee of $40,000. Most freight operators do not use an auxiliary power unit, and wheels and brakes have a cost of about $200 per FH. Avionic repairs are also made cheaply because of their simplicity, and in some cases fees are $1,500 per item. Autopilot units can be overhauled for about $6,000. "These low costs are commensurate with operations to Africa and the Middle East. Operations across Europe and the Atlantic will become more expensive because of the new avionics required," explains Donal James, technical services manager at Heavylift Engineering. "The 707 basically has high manhour consumption but parts are cheap in its current configuration, which compares with the very high cost of parts and equipment of an aircraft like the 757."

Younger types like the A310 will have many of the necessary modern avionics installed, and it will be easier to upgrade the autopilot for the aircraft to meet reduced vertical separation criteria.

The DC-8 will have about $100 per FH lower airframe maintenance charges than the 707 when not equipped with modern avionics. This is explained by the DC-8's airframe durability and low level of corrosion and structural problems.

The DC-8-55CF/-61CF and 707 use JT3D-3B and -7 engines. The two are similar. Light shop visits or hot section inspections are performed about every 5,500 engine flight hours (EFH) while heavy shop visits are carried out every 11,000 EFH. The average interval is therefore about every 5,500 EFH, although AD 60-38 relating to compressor corrosion influences removal rates.

Approximate third party costs for light visits are $325,000 while heavy shop visits incur about $650,000, including LLP replacement. This generates a cost per EFH of about $90, since workscope patterns usually require a heavy shop visit every other removal.

Lease rates for spare engines are about $450 per day plus engine reserves. An annual aircraft utilisation of 2,500 FH will generate about two engine shop visits per year, and so a spare engine lease cost in the region of $55,000 plus the equivalent of four months of engine reserves. Total engine-related maintenance costs will therefore be about $410 per FH.

There are still several JT3D facilities in operation, including M&M in Miami, and Modern Jet Support Centre in the United Kingdom.

Overall the 707 has maintenance charges of about $1,000 per FH. The DC-8's maintenance charges will be about $900 per FH.

The A310's maintenance charges work out at about $400 per FH for line and airframe checks, as much as $475 per FH for rotable provisioning and repairs and about $365 per FH for engine-related costs. This totals about $1,225 per FH. The A310's charges are effected by the high cost of supplying the high-tech rotables and spare engine provisioning. "The A310's ageing aircraft programme has not been established either," says Kruger "and there are also practical issues such as the cost of sourcing a spare engine when aircraft are stuck at remote airports."

Flight crew costs for the 707 and DC-8 will be similar. Depending on airline pay scales pilot costs will be similar to the A310. The only advantage the A310 can offer is the absence of a flight engineer.

Annual employment costs including training and subsistence vary between airlines over the world, but those for 707/DC-8/A310 captains might be $120,000, $90,000 for first officers and $75,000 for flight engineers.

On a typical annual productivity of 800 FH per crew member and annual utilisation of 2,500 FH, flight crew costs

PAYLOAD SPECIFICATIONS

	707-320C	DC-8-55CF	DC-8-61CF	A310-300F
MTOW (lb)	333,600	325,000	328,000	346,100
MZFW (lb)	230,000	224,000	234,000	251,300
OEW (lb)	135,000	127,450	148,000	162,900
Maximum structural payload (lb)	94,500	96,550	86,000	88,400
Upper deck container configuration				
125" x 88" x 82"	13	13	18	
Volume (cu ft)	5,954	5,954	8,244	
Tare weight (lb)	2,665	2,665	3,690	
88" x 125" x 96" (AAX)				16
Volume (cu ft)				8,000
Tare weight (lb)				8,480
Lower deck container configuration				
LD-3				14
Volume (cu ft)				1,974
Tare weight (lb)				2,282
Total payload				
Total container volume (cu ft)	5,954	5,954	8,244	9,974
Total tare weight (lb)	2,665	2,665	3,690	10,762
Net structural payload (lb)	91,835	93,885	82,310	77,638
Maximum packing density (lb/cu ft)	15.42	15.77	9.98	7.78

Rejuvenation costs for a 707 stands at about $4.5 million. This compares to a build cost of between $20 and $40 million for A310-300F.

will be $355 per FH for the DC-8 and 707, and $265 per FH for the A310.

Insurance premiums will be based on hull value, style of operation and airline track record. Values of 707s and DC-8s will be boosted to about $5 million following hushkitting. These will probably incur a rate in the region of 5%. An A310 valued at $30 million is more likely to have an insurance premium of 0.75%. The result is that the annual premiums for the aircraft almost balance out.

Finance charges

Aircraft finance charges is the most influential factor for 707 and DC-8 operators. Even if A310-300Fs were available at non-prohibitive lease rates they are unlikely to meet most 707 and DC-8 operators' payload requirements.

Most 707s and DC-8 are owned by their operators. These are likely to be fully or almost fully amortised. Finance charges will then just consist of hushkit amortisation, outstanding service bulletins or ADs and installation of avionics to allow the aircraft to operate unrestricted. Continued operation will also require heavy airframe checks and shop visits. Avionic upgrades may cost in the region of $0.5 million. Structural work for the 707 will add about another $1.0 million.

Life extension cost, including avionic upgrade, hushkit and structural work, for the 707 will be $4.5 million and $3.2 million for the DC-8. These investments will probably be amortised over five years. This will take the 707's and DC-8's finance charges to $99,000 and $70,000 per month when financed at 10% for aircraft that are otherwise fully written down by their airline owners. The aircraft could have their lives extended by up to 15 years. Resale values will also be boosted by hushkitting.

Dry lease rates for 707s are $35,000-$75,000 per month, $50,000 and higher for DC-8-50s and $60,000-$90,000 per month for DC-8-61Fs.

The A310-300F's build cost will be at least $20 million for the oldest model with a low specification MTOW (maximum take-off weight).

The A310-300 variant to match the 707's and DC-8's range is the aircraft with a MTOW of 346,100lbs. These aircraft still have market values of more than $30 million and so build cost for these will be at least $40 million. This would equate to a lease rate of about $450,000 per month.

A build cost of $20 million will result in a dry lease rate in the region of $280,000, which explains why 707 and DC-8 operators are sceptical about replacing their fleets. Airlines also have to

TRIP COST COMPARISON

	707-320C	DC-8-55CF	A310-300F
Gross payload (lb)	85,000	81,000	85,000
Net payload (lb)	82,335	78,335	74,238
Fuel ($)	9,606	9,686	6,680
Maintenance ($)	7,000	6,300	8,575
Flight crew ($)	2,485	2,485	1,855
Insurance ($)	700	700	630
Finance charges ($)	3,500	2,450	9,800
Total trip costs ($)	23,291	21,621	27,540
Operating cost per lb net payload ($)	0.28	0.28	0.37

Based on a 3,000nm/seven hour sector.

B707 USERS

ADC airlines	1	Libyan Arab Airlines	2
Aeca aeroservicios ecuatorianos	1	Lloyd Aereo Boliviano	2
Aero Asia	2	Lowa Ltd	1
Aero Zambia	1	Luxor Air	1
Aerpopostal de Mexico	1	Mahfooz Aviation	1
African Airlines International	1	Mas Air Cargo	2
Air Afrique	1	Middle East Airlines	2
Air Atlantic Cargo	1	Nigeria Airways	1
Air Memphis	4	Occidental Airlines	2
Air Nacoia	1	Omega Air	4
Angola Air Charter	1	Pakistan International Airlines	1
Aniaza	1	Quiet Skies Inc	1
Asnet Inc	1	Royal Jordanian	1
Aviation consultants	1	SAE Cargo	1
Avistar Ltd	1	Safair	2
Azza transport company	2	Saha Airlines	2
Beta Cargo	2	Scibe Airlift Zaire	2
Cielos del Peru	1	Seagreen Air Transport	4
Congo Airlines	2	Shuttle Air Cargo	7
Continental Cargo Airlines	1	Simba Air Cargo	27
Das Air Cargo	2	Sky Air Cargo	4
Egypt Air	1	Skymaster Airlines	1
Espace Aviation Services	1	Skypower Express Airways	2
Ethiopian Airlines	2	Sudan Airways	3
Falcon Enterprises	18	Summit Aviation	1
First International Airlines	1	TAAG Angola Airlines	5
Flying Dolphin Airlines	1	TAG Aviation	5
Grumman Aerospace Corp	2	Tampa Colombia	1
Interflight airline marketing	4	Trans Arabian Transport	1
Iran Air	2	Trans Mediterranean	4
Iran Air Tours	3	Transair Cargo	12
Jaro International	1	Transcontinental Sur	1
Kalair USA Corp	1	Uganda Air Cargo	4
Kuwait Airways	2		

DC-8-50/-61 USERS

Aeronorte Colombia	1	Fine Air	2
African International Airways	1	Florida West International Airways	1
Air Transport International	9	Liberia World Airlines	1
Airborne Express	9	Lignes Aeriennes Congolaises	6
American International Airways	2	MK Airlines	3
Arca Colombia	2	Trans Continental Airlines	6
ATC Colombia	9	Transair Cargo	1
Chrysler Corporation	2	Transportes Charter Do Brasil	3
Emery Worldwide Airlines	1		

consider spare parts and engine backup.

This dry lease rate is about $220,000 higher per month than the 707's and DC-8-50's market dry lease rates. The A310-300F is therefore $1,100 per FH more expensive on the basis of a monthly utilisation of 200 FH. This difference is conservative since the probable build cost of the highest gross weight A310-300 is closer to $40 million.

Dry lease rates for 707s and DC-8s on operating leases would increase after hushkit modification and avionic upgrades, reducing the finance charge difference with the A310, but the difference would still be in the region of $600 per FH. Even on a high rate of utilisation of 300 FH per month the A310-300F would still be more than $400 per FH more expensive.

The difference in finance charges between a 707 or DC-8 that is owned and has only the hushkit installation and avionic upgrade costs to amortise, and the A310-300F is between $180,000 and $210,000 per month. This makes the A310-300F at least $900 costlier per FH than the 707 or DC-8.

These differences in lease rates clearly show the A310's finance charges are too high to offset the 707's and DC-8's higher combined fuel, maintenance, flight crew and insurance costs. It illustrates clearly why 707 and DC-8 operators are reluctant to consider alternatives.

The straightforward comparison of finance charges is strengthened further when consideration is given to the fact that many 707 and DC-8 operators have some of the lowest credit ratings in the industry.

The implications are that 707 and DC-8 operators would not be able to get financing to build A310-300Fs even if they were forced into retiring their current fleets. A lessor would have to acquire the aircraft and put them on operating lease to the airlines, but the lessee's credit and the aircraft's lease rate itself would require a premium rate.

707 & DC-8 gulf

To illustrate the gulf between the operating costs of the 707/DC-8-50 and the A310-300, costs on a 3,000nm/seven hour sector have been compared. The 707 and A310-300F can each carry 85,000lbs but the DC-8-55CF is restricted to a 81,000lbs load. The charges included in the table are only those where there is a significant difference between the three types. For example, weight based landing charges and cargo handling are not included.

Fuel costs are based on a price of 65 cents per US gallon. Maintenance, flight crew and insurance costs are as described in this article. Finance charges for the 707 and DC-8-50 are for aircraft that have been fully amortised by their owners and just have the hushkit and other modification costs to amortise. The A310-300F's finance charges are based on a lease rate of $280,000 per month.

The finance charges of the three aircraft are highly variable, but whatever the scenario the 707 and DC-8 are hard to beat on a cost per lb of payload basis. The A310-300F's lease rate, moreover, is probably too low. Only the highest gross weight A310-300 can match the 707's and DC-8's range performance. This A310 would have a lease rate of at least $400,000.

The finance charges for the 707 and DC-8 are also punitive, since the hushkit and life extension modification is amortised over five years. Once this investment is paid off the aircraft become more economical.

The A310's high lease and maintenance charges are partially offset by its fuel efficiency and lower flight crew charges. Overall the A310 still has trip costs that are at least $4,000 higher than the 707 and DC-8. The A310's cost per lb of net payload is 32% higher and would almost certainly make the A310 uneconomical in this scenario. This is the case where the A310 has a lease rate of $280,000 but even more true for an A310 with the performance capability to match the 707 and DC-8.

The 707 and DC-8 score further points on the fact they have higher net structural payloads and that the A310 is likely to waste valuable volumetric payload on 707 and DC-8 routes. A more practical replacement for the 707 and DC-8 might be to use the DC-10-30 as a replacement on a three-for-two basis provided the route network and traffic allowed this to work economically. AC