The DC-8 & 707 have dominated the long-thin market for 20 years. Major airlines are now beginning to retire smaller widebodies. Do these aircraft have the operating performance and low enough market values to make them viable replacements for the DC-8 & 707?

New freighters for long-thin markets

The DC-8 and and 707 have been the prime aircraft for the long-thin freight market for more than 20 years. The DC-8 has also been a workhorse on the longer domestic US routes. However, all freight traffic and fleet growth forecasts indicate that the large narrowbody fleet of DC-8s and 707s will diminish in size over the next 10–20 years. In turn the small- and medium-sized widebody freighters, that is, the 767s, A300s and A310s, will replace these older aircraft.

This replacement will take place on the basis that traffic will grow, making the DC-8 and 707 too small. The DC-8 and 707 are also ageing and many will be retired because of increasing operating costs and noise issues. Some freight operators are already in the process of replacing or assessing DC-8 and 707 replacements.

Since one of the DC-8s' and 707s' major roles is operating low traffic density, long-distance routes, do the younger widebodies have the operating and economic performance required as replacements?

DC-8 & 707 dominance

There are several factors that have prevented aircraft from displacing the DC-8 and 707. Traffic growth, or at least static traffic volumes, dictate that DC-8 and 707 replacements have the same structural and volumetric payloads and complimentary range performance.

Because the economics of freight aircraft means that a large replacement will be uneconomic because of low load factors and wasted capacity, replacements will need to have similar payloads to the DC-8 and 707. This immediately rules out types such as the DC-10.

The DC-8-73AF, for example, the largest narrowbody freighter, has a net structural payload of 106,000lbs after deducting weight of containers. The DC-10-30 by comparison has a net structural payload of 183,000lbs.

This then dictates that replacement candidates, at least in low-density markets, to replace the DC-8 and 707 will be the smallest widebodies. On a comparative payload basis, they provide the smallest increase in aircraft size and payload capacity that will be required after taking account of traffic growth.

The 767, A300, A310 and 757 are the candidates most suitable for direct DC-8 and 707 replacement.

Most freight operators have an average packing density of 7lbs per cubic foot. Once tare weight and container volume have been considered, the DC-8-73AF and -63AF each have a volumetric payload of 57,708lbs. The DC-8-55AF and 707 each have a capacity of 41,678lbs.

These four aircraft all have long-range capability compared to their maximum structural payloads. Moreover, these

Paradoxically the DC-8-63 has competitive economics because of low lease rates as a consequence of being overshadowed by the DC-8-73. This makes it hard for the 757 and widebodies such as the 767, A300 and A310, to offer lower costs per ATM.

aircraft also have high maximum zero fuel weights and structural payloads compared to their volumes. This makes their packing densities considerably higher than 7lbs per cubic foot. The narrowbodies are thus flexible and still have long-range capability with full structural payloads.

Despite being closest in size to the DC-8s and 707, the 767, A300 and A310 have 20–40% larger volumetric payloads, making it hard for airlines to jump to the larger aircraft. At the same time, the widebodies still have high market values and lease rates, which make it hard for them to offer better economics. This has kept the DC-8 and 707 in favour.

The situation is slowly beginning to change, as major passenger airlines are showing signs of replacing 767s, 757s and A300s and so are looking for secondary markets. With low market values and cash operating costs, the widebodies are becoming a digestible option for airlines.

Replacement candidates

There are several variants of each of the four replacement candidates. The oldest, or those with lowest market values, will have financing or leasing charges low enough to make them economically suitable against the DC-8 and 707. Conversely, these models will have low gross weights and short-range performance.

The 767-300PF is a factory-built freighter. It has a net structural payload of 120,040lbs *(see table, page 46)*, making it the largest DC-8 replacement candidate. After purchase discounts, it will still have a monthly lease rate of about $700,000. This compares to about $220,000 per month for the DC-8-73, thus making a new factory-built 767F too expensive for consideration.

A freighter conversion programme has recently been launched by Boeing for the 757, and there is industry speculation that one will soon be launched for the 767. If this is the case, the oldest 767s can be bought from airlines and lease rates for converted -300s will be in the region of $350,000. These will have similar payload characteristics to the 767-300PF, and so the converted aircraft will have competitive economics.

The 757PF is also too expensive as a new aircraft. The recently launched conversion programme for passenger aircraft means aircraft could become available at monthly lease rates of about $225,000.

The 757 is the smallest of the DC-8 and 707 replacements. At a packing density of 7lbs per cubic foot, the converted 757 has a volumetric payload of 46,200lbs. This is only 3,300lbs more than the DC-8-55AF and the 707-320C.

NARROWBODY FREIGHTER PAYLOAD AND RANGE CHARACTERISTICS

Aircraft type	757-200F	DC-8-73AF	DC-8-63AF	DC-8-55AF	707-320C
Maximum structural payload lbs	86,980	111,030	115,230	95,230	93,670
Container type	125/88/82	125/88/82	125/88/82	125/88/82	125/88/82
Tare weight lbs	3,750	4,500	4,500	3,250	3,250
Container volume (cu ft)	6,600	8,244	8,244	5,954	5,954
Packing density (lbs/cu ft)	7.0	7.0	7.0	7.0	7.0
Volumetric payload lbs	41,678	57,708	57,708	41,468	41,678
Max range with payload (nm)	4,000	4,500	4,000	4,000	4,500
Average sector length nm	3,000	3,000	3,000	3,000	3,000
Annual aircraft productivity (ATM/year-millions)	17.7	24.5	24.5	17.6	17.7
Annual crew cost $	210,000	285,000	285,000	285,000	285,000
Monthly lease rate $	225,000	220,000	90,000	75,000	70,000

The next largest aircraft is the A310. So far only the lower gross weight -200 series has had a conversion programme. Most -200s have been converted, however, and a programme for the -300 is expected to be launched soon. Aircraft with medium and high gross weights are likely to be considered by freight operators. Medium gross weight aircraft can match the payload-range performance of the DC-8-55 and 707.

At a packing density of 7lbs per cubic foot, the A310-300's volumetric payload is 70,308lbs. This gives it 20% more capacity than the DC-8-63/-73. The highest gross weight A310-300, however, has a 3,500nm range, compared to the DC-8-73's 4,500nm capability.

The A300B4-200F has a volumetric payload of 83,280lbs, but only a range of 2,000nm. This means the A300B4-200F can only compete indirectly with the DC-8 and 707, where it would have to operate multiple stop sectors. The majority of A300B4s have been converted to freighter and have lease rates in the region of $200,000 per month.

There are 30–40 good quality A300B4s left, after which either the A300-600 or 767-300 will start to get converted. The first will be the one with lowest market values and the capability to match market needs.

The A300-600 has a volumetric payload of 93,350lbs and range of 2,500nm. This makes it less appealing than the 767-300 and limits the A300's ability to compete with the DC-8 and 707 as a long-haul aircraft.

A new factory-built A300-600F will have a market lease rate in the region of $650,000, while a converted aircraft will be able to command a rate of up to $300,000.

Range performance

While the DC-8-63AF has a range of 3,500nm, all other DC-8 variants and the 707-320C have a range of at least 4,000nm with their payloads.

The payload-range profiles of the widebody replacement candidates is different to the DC-8s and 707s. While the widebodies have higher structural payloads, their payloads start to reduce at ranges of about 3,000nm. After this distance payloads are diminished close to the level of the DC-8s and 707s at 4,000nm.

At 4,000nm, the 767-300F has a net payload of 87,000lbs. The A300-600's payload is reduced to 52,140lbs, the A310-300's payload to 56,000lbs, while

WIDEBODY FREIGHTER PAYLOAD AND RANGE CHARACTERISTICS

Aircraft type	767-300PF	A300-600F	A300B4-200F	A310-300F
Maximum structural payload lbs	120,040	109,210	99,230	85,770
Container type	88/125/96 LD-2	88/125/96 LD-3	88/125/96 LD-3	88/125/96 LD-3
Tare weight lbs	17,010	15,860	13,840	11,490
Container volume (cu ft)	15,696	13,712	11,920	10,044
Packing density (lbs/cu ft)	7.0	6.8	7.0	7.0
Volumetric payload lbs	103,000	93,350	83,280	70,308
Payload at 4,000nm lbs * 3,000nm max range	57,708	52,140	49,000*	56,000
Average sector length nm	3,000	3,000	2,000	3,000
Annual aircraft productivity (ATM/year-millions)	24.5	22.1	20.8	23.7
Annual crew cost $	220,000	220,000	300,000	220,000
Monthly lease rate $	350,000	300,000	200,000	250,000

the 757 can still carry its volumetric payload of 46,200lbs. These payloads take into account the tare weight of containers and packing density of 7lbs per cubic foot.

While these payload capabilities still exceed the DC-8 variants' and the 707's at the same distance, the payload capacity of the widebodies will be reduced at the critical 3,000–4,000nm sector lengths that are important in the long-thin markets. This will cause their unit costs per available ton-mile (ATM) to rise as payloads reduce on sector lengths longer than 3,000nm.

The A300-600's and A310-300's payloads at 4,000nm are almost identical to the DC-8-63AF's. This at least means the A300-600 and A310 can compete with the DC-8-63. Provided lease rates are low enough, airlines could be persuaded to operate the A300-600 and A310-300 on the edge of their payload-range envelopes.

The 767-300F would still have a 87,000lbs payload and be able to offer airlines growth capacity. Combined with low cash operating costs, the 767-300 could be an economic solution to replacing the DC-8-73. The A300-600F, however, could provide sufficient performance and may be the economic solution to match the DC-8-63 for airlines that do not require so much range capability.

The A310's disadvantage is that it has similar cash operating costs but smaller payload compared to the A300-600.

On a payload and range basis the 757 has performance to match the 707 and DC-8-55. The 757 only requires a low enough lease rate.

Replacement economics

The economic basis for replacing the DC-8 and 707 will be on the ability for their closest replacement candidates to carry the same or similar payloads at lower or equal operating cost.

The route lengths DC-8 and 707 operators perform are up to 4,000nm in most cases. The pattern of operation often means annual utilisations are low. Carriers either operate one return flight a day in small package operations, or longer distance ad hoc or scheduled missions with low frequencies.

The 767-300, A300-600, A310-300 and 757 have already demonstrated they can carry the same or similar volumetric payloads packed at 7lbs per cubic foot 4,000nm compared to their closest or direct competitors.

That is, the 757 competes closest to the DC-8-55 and 707, the A300-600 and A310-300 with the DC-8-63 and the 767-300 with the DC-8-73.

The economic basis for comparing these aircraft will be to analyse their costs per available ton-mile (ATM) on a range of sector lengths up to 4,000nm, carrying the same payload permissible of the appropriate DC-8 variant or 707 on a 4,000nm sector.

This is because DC-8 and 707 operators that want to replace their aircraft will not be able to provide higher payloads to fill larger aircraft to begin with. The larger capacity aircraft may, however, allow airlines to offer freight to forwarders at lower rates.

The 707 and DC-8-55 with a volumetric payload of 41,468lbs will be compared to the 757 with an equal payload. The DC-8-63 with 57,708lbs will be compared to the A300-600 carrying 52,140lbs and the A310-300 with 56,000lbs. Finally, the 767-300 will be analysed against the DC-8-73's 57,708lbs payload.

The DC-8s and 707s are operated by most airlines on the basis of a range of sector lengths between 2,500nm and 4,500nm. Average sector lengths will be in the region of 3,000nm, or a seven-hour sector.

Annual utilisations will be in the region of 2,500 flight hours (FH) and so about 310 flight cycles (FC) per year. With an average sector length of 3,000nm, the ATM productivities of the aircraft will be 17.7 million for the 757, DC-8-55 and 707, 24.5 million for the DC-8-73, -63, A300-600, A310 and 767-300.

The big influence on the ability of younger aircraft to displace the DC-8s and 707s will be the trade between high cash operating costs of the older aircraft and the high lease charges of the 757 and widebodies.

Now that major airline fleets are being retired and the number of passenger-configured 757s, 767s, A300s and A310s exceeds the number likely to be converted, values will fall as aircraft are retired. These aircraft will come from large major carrier fleets, will have uniform specification and generally have good maintenance standards and records.

Buyers and lessors will still have to spend additional sums on acquisition maintenance and freight conversion. Cost of conversion for the A300/310 is in the region of $6.5 million, while it is believed to be about $5 million for the 757 conversion.

Despite total acquisition costs, lessors will only be able to generate lease rates that the market can bear. These will be determined by overall aircraft operating costs.

Economic comparison

The four operating costs included in the analysis are fuel, maintenance, flight crew and lease charges.

The lease charges used for the DC-8s, 707 and A300B4 are representative of industry rates*(see tables, pages 45 & 46)*. In the case of the DC-8 and 707, the lease rates are those expected for DC-8-55/-63s modified with Stage 3 hushkits. The ones for the 767-300, A300-600, A310-300 and 757 are levels which are expected to be the market level for these types.

The fuel charges are based on a cost per US gallon of 60 cents. Fuel burns are for current aircraft configurations relating to weights and engine modifications. That is, they are the levels for Stage 2 DC-8-50s/-60s and 707s.

Burbank Aeronautical has developed a winglet system for the 707 which, at a cost of $400,000, reduces fuel burn by 7%. The winglet then increases range by about 500nm, which extends the capability over that shown in the table. This reduction is in addition to the fuel burn reduction that its Stage 3 hushkit achieves over the Stage 2 modified aircraft.

Maintenance charges take account of average sector length and level of utilisation. Although aircraft such as the 757 and A310 have twin engine economics, the older 707 and DC-8 often have cheaper components. This is explained by there being a lot of inventory available now that the DC-8 and 707 fleets have contracted, but also because components are not so technologically advanced.

There is also little A300-600, A310, 767 and 757 material available on the secondary market. This is likely to change as more aircraft get retired from major passenger fleets. This has already occurred after industry vendors, including Aviation Sales and Aviation Systems International acquired A300B4 inventory.

The older aircraft will also be able to counter engine maintenance costs by avoiding shop visits and cannibalising time continued engines. Engine inventory costs will also be low because of the low market value of engines.

The younger aircraft can counter this with lower manhours for airframe checks, longer on-wing times and a need for fewer spare engines.

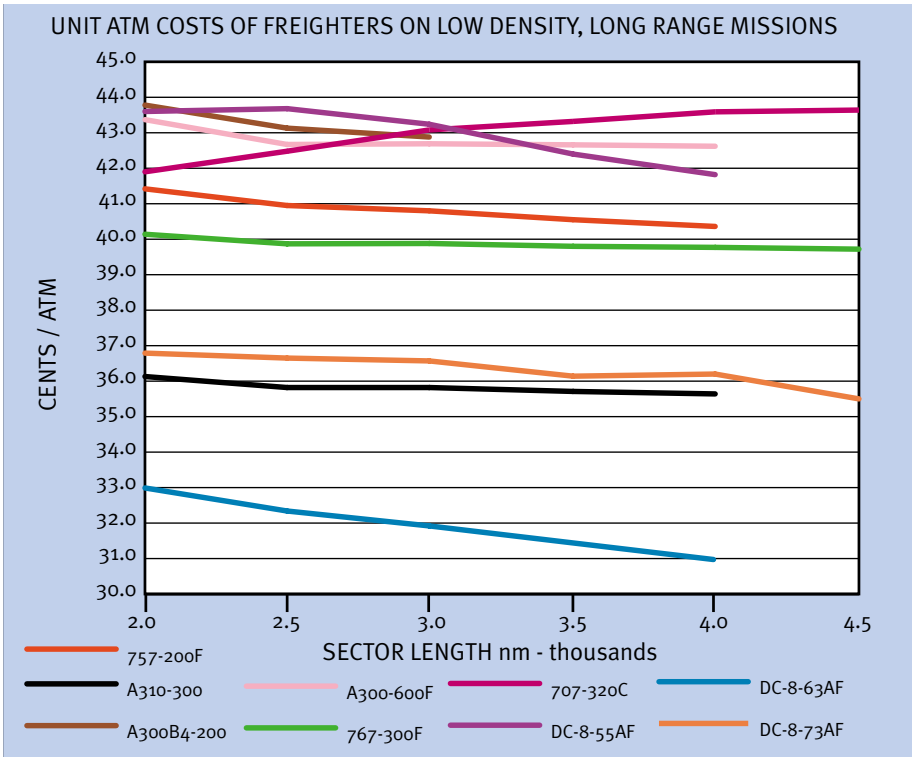
Overall, the total maintenance costs of DC-8s and 707s are closer to younger aircraft than many might expect.

Total costs per FH here include an allowance for a power by the hour package of line replaceable units and rotables. The 757 is analysed here with FH costs of $1,000, the DC-8-73 with $1,200 and the DC-8-63/55 and 707 with $1,250. The larger 767, A300-600 and A310 use $1,250, while the A300B4 has costs of $1,325.

The flight crew costs are shown in the table. The younger aircraft all take advantage of their smaller crews and it is assumed supernumerary crew are not rostered. Because of the pattern and utilisation and low frequencies, pilot productivity is low. An annual FH productivity of 500 is therefore assumed. This means an average of four and a half crews are required for each aircraft.

The unit costs achieved for flight crew and lease charges are dependent on annual aircraft productivity. Total annual crew and lease charges are therefore amortised over the ATM productivity of each sector as a proportion of annual productivity to arrive at unit costs for these two elements. Actual costs will be lower than those shown in the chart *(see page 48)* if widebody operators are able to get higher payloads.

The lease rates assumed for the 767-300, A300-600, A310-300 and 757 allow



The 757 will present itself as a DC-8-55 and 707 replacement contender on long-thin markets if its lease rates are in the region of $225,000 per month or less.

them all to generate competitive costs per ATM. The A300B4 is also able to generate costs at an acceptable level at a monthly lease rate of $200,000.

The 757 at a monthly rate of $225,000 can generate costs about 1.3 cents per ATM lower than the DC-8-55 and about 3 cents lower than the 707-320C. The DC-8 and 707 cost profiles are similar, but the 757 demonstrates here that with low enough acquisition costs it can provide most carriers with an alternative to the DC-8-55 and 707. This relies on a lease rate of $225,000, which will only be achieved if aircraft can be acquired by lessors and freight operators in the region of $15 million.

The DC-8-63AF achieves the lowest unit costs of all aircraft. This is explained by it being overshadowed by the highly rated DC-8-73AF. Consequently, market lease rates for DC-8-60s are low at $90,000 per month. The low demand for DC-8-60s paradoxically keeps them economical for existing operators that do not need the -73's range capability.

The DC-8-63's unit costs are therefore too low for the A300-600 and A310-300. The A310 has costs of about 3 cents per ATM higher, while the A300-600 is 10–11 cents per ATM higher. If the A300-600's and A310's capacity is not required then the DC-8-63 can maintain its position. Higher loads will bring down the A300's and A310's unit costs, but this first requires sufficient levels of traffic growth.

This is in the scenario of the A300-600 and A310 having lease rates of $300,000 and $250,000. It is possible these could get lower as more are converted and when the A300B4's rate of $200,000 is taken into account.

The A300-600 and A310-300 are therefore not suited to replacing the DC-8-63 in the long-thin markets, but will be competitive in high-density, short-distance markets.

Despite its popularity and high lease rates, the DC-8-73 is able to keep ahead of the 767-300 with a lease rate of $350,000. The gap between the 767 and DC-8-73 is about 3.50 cents per ATM. This will be closed when the 767 carries higher loads or is available at lower lease rates. The 767's payload capability also outstrips the DC-8-73's on all sector lengths. The 767 is therefore positioned as a strong DC-8-73 replacement candidate. The 767-300 will be able to operate the same US domestic and international long-haul routes as the DC-8-73.

The DC-8-73 will still remain popular. Not all airlines will want to incur the cost of a fleet change and it will be several years before the first 767-300s are converted and become available. Freight traffic growth will also ensure that DC-8-73s are kept active for as long as possible, while older DC-8-60s and -50s will be retired in favour of younger aircraft.

The 757 and 767-300 are therefore in strong positions to replace the DC-8-55s and DC-8-73. Although the DC-8-63's unit costs are low, many airlines will still be considering replacements if their other DC-8 variants are being disposed of. Airlines may then have to compromise between a mixed fleet of 757s and 767-300s in this respect.

The 757 and 767 of course have the benefit of commonality in spare parts and also a common type rating.

This analysis has so far ignored the 767-200. This is because the 767-200 will have similar trip costs but a smaller load to the -300. The -200 is still likely to have a structural payload in the region of 85,000lbs. Higher gross weight -200s will also have the range capability to match the DC-8-73 and so could be contender on a performance basis.

The -200's age and smaller payload will mean many carriers will be prepared to wait until enough 767-300s are retired and values have fallen. AC