

Replacement of the 727-100F/-200F has been anticipated for several years, but the values of some replacement candidates are only now approaching the zone of convertibility. Conversion programmes are becoming available. This raises the issue of which aircraft are best placed as replacements.

The options for 727F replacement

The 727-100F and -200F continue to operate in large numbers, with few airlines so far seeking to replace them, due to there being few replacement candidates until now. This situation has begun to change, with several conversion programmes for the 737-300/-400 and 757-200 already available or becoming available in the next 12-24 months. This will at least provide 727F operators with potential replacements, although airlines will need to be convinced of the economic rationale.

727s in operation

The majority of 727Fs operate in North America, carrying small packages and express freight for integrators. Other small fleets operate in Europe.

There are about 70 727-100Fs in service, most of which are close to 30 years old. There are another 220 727-200Fs in service, the youngest now 21 years old and oldest up to 30 years. Despite their age, they meet noise requirements and provide good economics.

The 727F's main advantage is its low lease rentals or depreciation costs, which have the highest impact on unit operating costs under low utilisation operations. Many operators achieve little more than 1,200 flight hours (FH) per year. These finance charges are low enough to override its high cash operating costs.

Ryan International, for example, operates 15 727-200s for Emery Worldwide. "We achieve about 80 flight hours (FH) per month, and have no thoughts of replacing our 727-200s," says Jeff Crippen, president of Ryan International. "Lease have fallen to about \$50,000 per month. We cannot justify the 757 because we do not need a larger aircraft."

The 727's low finance charges are the

main challenge to replacement candidates. Replacement candidates will offer similar structural payloads and container volume capacity. Many operators require replacements to have the same fuselage cross-section as the 727 to maintain container commonality. The 727 has a 125-inch by 88-inch by 82-inch standard maindeck container. The MD-80 would require a narrower container, which rules it out of consideration as a possible 727 replacement.

The only aircraft with the same fuselage cross section and similar container and freight volume capacities as the 727-100F/-200F following conversion are the 737 and 757. The Tu-204, is also a possibility, although this has yet to receive western certification.

"The 727 made a great freighter and is still working well in some markets. The straight across replacement for the 727 is not available today," says Kevin Casey, vice president of commercial business development at Pemco. "We should expect to see mixed fleets of 737-300/-400 with 757s or mid-size widebody aircraft in markets once dominated by 727s. The 737-300 will be the small freighter of choice for many years. Pemco is well suited to offer freighter operators and owners reliable passenger to freighter programmes."

Most freight operators do not need to add flight frequencies to improve service level. Static traffic volumes mean that carriers will only be interested in similar-sized or even smaller aircraft. Traffic growth will necessitate large aircraft, but only after a sustained period.

The density of most freight is 7lbs per cubic foot. Volumetric payload (container volume multiplied by packing density) is lower than structural payload when the aircraft is full. Payload capacity therefore depends on containerised volume, rather than structural payload. Aircraft operating excess of freight volume and

capacity are likely to have poor economic performance.

The 737, 757 and Tu-204 will have to offer trip costs and unit costs per lb of payload that are lower or equal to the 727-100F/-200F. This will be with a combination of the younger types' lower cash operating costs and sufficiently low lease rates or finance charges.

Besides the 737 and 757, some 727 operators may consider replacing their aircraft on a two-for-one basis. FedEx, for example has already done this with the 727-100F and A310-200. TNT has already partially replaced its 727-200s with A300B4s.

Other carriers are considering similar strategies. "We only fly our 727-200s about 5FH per day, and are looking at DC-10-30s as a potential replacement on a two-for-one basis because of our route structure," says Barry Lapointe, president of Kelowna. "The DC-10-30 has low values in the region of \$6 million and would have a low financing charge."

Economics of replacement

Replacement candidates have to be available at low enough lease rates for airlines to consider them. These lease rentals thus put a limit on the total cost of acquiring, converting and making an aircraft available for operation. Aircraft values therefore have to fall to the economic zone of convertibility. Values of 737-300s/-400s and 757-200s have fallen dramatically in the past 18 months, which coincides with continued development of various passenger-to-freighter conversion programmes.

The fall in value of 737s and 757s could make it possible to convert them at a total cost that allows a lease rate acceptable to 727 operators. The issue is, therefore, whether values of used aircraft are low enough for them to replace the 727 in low utilisation operations.

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PAYLOAD SPECIFICATIONS OF 727-100F/-200F AND REPLACEMENT CANDIDATES

Aircraft type	727-100F	727-200F	737-300	737-400	Tu-204	757-200SF	A310-300
Structural payload-lbs	43,000	59,000	44,860	51,000	59,700	70,000	88,000
Maindeck container type	125/88/82	125/88/82	125/88/82	125/88/82	125/88/82	125/88/82	88/125/96
Maindeck containers	9	12	8	9	14	15	16
Maindeck container volume-cu ft	4,122	5,496	3,664	4,122	7,524	6,870	8,000
Total freight volume-cu ft	4,860	6,715	4,732	5,497	7,524	8,280	10,044
Volumetric payload-lbs	34,020	47,005	33,124	38,500	52,668	57,960	70,308

Replacement candidates

The 727-100F carries nine of its standard maindeck containers, giving it a volume of 4,122 cubic feet. Additional underfloor volume takes total freight volume to 4,860 cubic feet, and a volumetric payload of 34,000lbs (see table, this page).

The 727-200F carries 12 of the same containers. Total freight volume is 6,715 cubic feet and volumetric payload 47,000lbs (see table, this page).

737-300/-400

Two major 737-300 conversion programmes are offered by Pemco and

Bedek Aviation. List prices are \$1.7-2.5 million.

Pemco already has a supplemental type certificate (STC) for the 737-300 and recently won a contract from GECAS to convert 10 737-300s. Pemco's conversion is the only 737 programme to have Chinese certification.

Pemco has not yet started development of a 737-400 modification STC, but says it could do this in about one year with demand from a launch customer. The process would be relatively easy, since it has a STC for the -300.

GECAS has already signed a contract with Bedek for a firm order to convert 25 737-300s. Bedek is currently developing its STC of the 737-300 modification, and

expects to receive the STC by May 2003.

Bedek has not yet started development of the STC for the 737-400, since it does not have an aircraft supplied by a launch customer. It reports there is interest in the market and expects development to start in 2004.

The 737-300 has a structural payload of about 44,860lbs. Its fuselage accommodates eight 125-inch by 88-inch by 82-inch containers on its maindeck (see table, this page). These are the same containers used on the 727's maindeck, as well as on the 757 and Tu-204.

The 737-300's eight maindeck containers provide a volume of 3,664 cubic feet. It also has some underfloor volume, taking the total volume to about



4,700 cubic feet. A packing density of 7lbs per cubic foot generates a volumetric payload of 33,100lbs (see table, page 48). This makes the 737-300 almost identical in capacity to the 727-100F.

The 737-400 accommodates nine containers, which gives it the same containerised volume as the 727-100F. When the 737-400's underfloor capacity is considered its total capacity is 5,500 cubic feet, taking volumetric payload up to 38,500lbs (see table, page 48).

The 737-300 and -400 therefore provide 727-100F operators with aircraft that offer a combination of identical and larger replacements. The 737-400 would provide some extra capacity for growth. The 737-400's capacity is about 10,000lbs less than the 727-200.

TNT has partially replaced its 727-200s with A300B4s. "We also operate two Super 27s, two Tu-204s and Lockheed Electra turboprops as short-term replacements," says Tom Storey, direct of fleet development at TNT. "We will probably have to get a mixture of 737s and 757s to complete the fleet modernisation. Although no 737-400s have been converted, they would be a good Electra replacement."

Values of 737-300s have now fallen to about \$6 million. Conversion to freighter and installation of a freight handling system is in the region of \$2.5

million. Additional costs for heavy component maintenance and a shop visit at or soon after conversion will take total cost to about \$11 million (see *Are aircraft values low enough to trigger a wave of conversions?*, *Aircraft Commerce*, December 2002/January 2003, page 41).

Values of 737-400s are higher, at about \$9 million. The -400 will have similar conversion and maintenance costs to the -300, and so the total cost for making the 737-400 serviceable as a freighter would be in the region of \$14 million if a modification programme were available. The fall of 737-400 market values lags behind the 737-300's, which should trigger conversion of the first -400s in 2004 or 2005.

757-200

Precision Conversions and Structural Integrity Engineering (SIE) are both developing a passenger to freighter conversion STC for the 757-200. Only Boeing has so far offered a conversion for the 757, which provided capacity for 14 containers. Conversions by Precision and SIE will both allow 15 maindeck containers, taking volume to 6,870 cubic feet. Additional underfloor volume will take the total to 8,280 cubic feet. Volumetric payload will be about 58,000lbs (see table, page 48).

The 757-200 is the next largest aircraft to the 727-200, with an 11,000lbs higher capacity. This can only be utilised if 727-200 operators experience high load factors and require extra capacity due to traffic growth.

The 757-200SF could also be considered by 727-100 operators as a two-for-one replacement where an exact doubling of capacity is not required. The 757-200SF has 70% more volumetric payload than the 727-100F. The 757-200SF could thus efficiently replace two 727-100Fs which operate on average with load factors of about 80%.

SIE and Precision both expect to have their first aircraft inducted for conversion later in 2003 and to be able to offer conversions from 2004. Precision Conversions has selected Goodrich Aviation Technical Services to perform freighter modifications. AHF Ducommun AeroStructures has been selected to manufacture parts and tooling. Precision expects to be able to offer modifications by the end of 2003, with a list price of about \$4.5 million.

SIE has selected ATC Lasham in the UK to perform modifications, and also has a list price of \$4.5 million.

Values of 757s have fallen in the past 18 months, and up to 80 are available on the used market. This represents about 10% of the global fleet and includes

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aircraft ranging from five to 20 years old. Substantial fleets have been parked, including those of USAirways and National Airlines. Values have fallen to about \$12 million in some cases, although book values are higher. The total cost for acquisition, conversion and probable additional maintenance will be in the region of \$19 million for aircraft with the lowest values (*see Are aircraft values low enough to trigger a wave of conversions?*, *Aircraft Commerce*, December 2002/January 2003, page 41).

In addition to SIE and Precision conversions, Pemco has also started work on developing an STC for 757 freighter modification. It expects to induct its first aircraft in 2004 or 2005. It will accommodate 15 containers and have a list price of about \$4.5 million.

The 757 passenger market is still weak, and values could fall further. The market for 757SFs has not yet developed, primarily due to the unavailability of low-cost passenger-to-freighter modifications. A high volume of 757 conversions will not be reached before 2005. By this time 727-200s will be two years older, and demand for 757SFs could have increased. Current high fuel prices and rising maintenance costs could accelerate 727-200 retirements.

Storey predicts TNT will require some 757-200SFs to complete part of its 727-200F replacement. "We need an aircraft larger than the 737-400 in some cases to match demand. Our Super 27s are marginally Stage 3 compliant, and values of 757-200s have come down a lot," says Storey. "Values of 757-200s need to come down further, since lease rates would probably have to be less than \$200,000 per month."

Robert Convey, director of operations at SIE expects the 757SF market initially to be pushed by lessors and owners of aircraft converting their aircraft, rather than demand from freight operators pulling the aircraft into the market. He says some 727-200F operators, however, that are beginning to show signs of interest in the 757-200SF.

A310-300

The A310-300 is the next largest aircraft airlines could consider as a replacement on a two-for-one basis. The A310-300's volumetric payload is exactly twice that of the 727-100F, and 50% higher than the 727-200F. The A310-300 could thus be used to replace two 727-200Fs for operators which have load factors of up to 75%.

Like all other types, A310-300s have experienced a fall in market values. Availability has increased, but Jurgen Haberman, vice president sales and marketing at EADS-EFW says he expects values to fall even further as aircraft from Cyprus Airways, Singapore Airlines and Aeroflot come onto the market.

Haberman concedes the A310-300 is probably too heavy for short routes compared to the A310-200. At low market values and consequently low lease rates, the A310-300's total costs could be competitive. The A300B4F, for example, has been used as a two-for-one 727-200F replacement by some carriers, including TNT.

Haberman predicts that values will fall to the region of \$6-9 million. Values are currently in the range of \$9-13 million. List price for conversion and installation of a freight handling system is

The surplus of aircraft has brought their values down to the zone of convertibility. The total cost of acquisition, conversion and maintenance will result in lease rates that have begun make them attractive replacement candidates for the 727-100F/-200F. This coincides with the development of various passenger-to-freighter modification programmes.

\$7.6 million. Additional maintenance costs takes the total to make a freighter available for service to \$21-25 million. Haberman says values of some aircraft are now low enough for the total cost of producing a freighter to be as low as \$18 million.

Tu-204

The Tu-204 will only be available as a new aircraft. It is due to receive western Joint Airworthiness Authority (JAA) 125 certification later in 2003. JAA certification is required for delivery of Tu-204s ordered by Chinese carriers. Federal Aviation Authority could happen relatively easily once JAA certification is awarded.

A small number of Tu-204Fs are already being chartered by carriers such as TNT. The Tu-204F accommodates 14 standard containers: two more than the 727-200F. This gives the Tu-204 a maindeck volume of 7,524 cubic feet (*see table, page 48*). Additional underfloor volume takes volumetric payload up to 52,600lbs, 5,600lbs more than the 727-200F (*see table, page 48*).

The Tu-204F's list price is in the region of \$41 million. Airlines can probably expect purchase discounts similar to those offered by other manufacturers, and so actual purchase prices may be in the region of \$27 million. Although lease rate factors for new aircraft are less than for converted freighter aircraft, the Tu-204's lease rates would still be higher than a converted 757-200SF's. The Tu-204's position will depend on purchase discounts.

Economic analysis

The economic performance of the 727-100F/-200F and replacement candidates should be analysed for low utilisation operations in Europe and the US.

European freight operations are often based on two return flights per night, or connecting routes. Average stage lengths are in the order of 600nm or 95 minutes' flying time, which are short compared to the US. Operations are often five nights per week, meaning aircraft will accumulate about 1,000 flight cycles (FC) per year, or about 1,550FH annually.

US freight operations are based on

longer sectors of about 700nm, but only one return flight per night for five days per week. Utilisation in this case is about 600FC and 1,100FH annually.

Freight operators need to match aircraft size with freight demand to avoid excess capacity and operating cost and make maximum benefit of revenue.

It is best therefore to analyse the economic performance of each type for a range of freight volume on a route.

The economic performance is the gross profit of each aircraft: the revenue for a given freight volume less the trip cost of a flight or multiple flights by each type as required to carry that freight. As the freight volume rises, trip costs remain the same and gross profit rises in proportion with revenue. When freight capacity is full, a further trip is added, increasing costs. An alternative is to change to a larger type. Further trips or capacity is not added at 100% load factor, but more likely at 90%. Thus, a 727-100F becomes 90% full at about 30,600lbs, when more capacity is added.

A daily freight volume of 50,000lbs would thus generate the same revenue if a 727-100F or 757-200SF were used, but two 727-100F trips would be required compared to a single 757-200SF operation. The most economic option would depend on the relative trip costs of the 727-100F and 757-200SF.

A daily freight volume of 30,000lbs could be carried in single trips by all types. The aircraft with the lowest trip cost would have the largest gross profit.

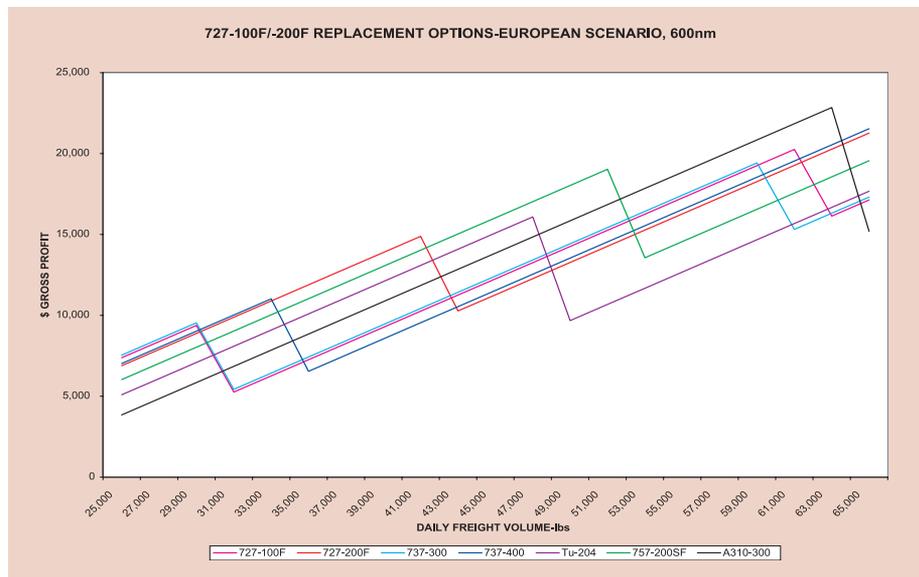
The analyses have been conducted to show the gross profit performances of the aircraft types over a daily freight volume of 25,000-65,000lbs. This illustrates the gross profit performance of the aircraft for daily freight volumes that require single daily trips by each aircraft type, but also two daily trips for smaller aircraft.

Revenues generated are based on 50 cents per lb of freight. This rate is arbitrary, and is only necessary to allow relative differences between types to be illustrated. That is, the difference in gross profit performance between types is equal to the difference in their trip costs.

Overall trip costs will depend on the combination of utilisation and lease rates. Lease rates for 727s have fallen, although many aircraft will already be owned or operated on existing lease terms.

Monthly lease rates used for the 727-100F are \$30,000 and 727-200F \$50,000. This compares to likely lease rates of \$150,000 for the 737-300, \$170,000 for the 737-400, \$300,000 for the Tu-204, \$200,000 for the 757-200SF and \$230,000 for the A310-300.

The lease rates used for the 727-100F/-200F are current market rates. Airlines which acquired 727Fs four to eight years ago will have started leases with rates higher than this. They may,



OPERATING COST ASSUMPTIONS FOR AIRCRAFT ON EUROPEAN 600NM ROUTE

Annual utilisation: 1,600FH, 1,000FC

Fuel price: 90 cents per US Gallon

Maintenance costs: 727-100F/-200F: \$1,360/FH; 737-300/-400: \$950; Tu-204: \$1,100/FH; 757-200SF: \$1,070/FH; A310-300: \$1,800/FH

Annual crew costs: 727-100F: \$225,000; 727-200F: \$231,000; 737-300: \$162,500; 737-400: \$169,000; Tu-204/757-200SF: \$194,000; A310-300: \$206,000

Annual crew productivity: 550FH

Annual engine inventory costs: 727-100F/-200F: \$15,500; 737-300/-400: \$50,000; Tu-204/757-200SF: \$69,000; A310-300: \$101,000

Monthly lease rentals: 727-100F: \$30,000; 727-200F: \$50,000; 737-300: \$150,000; 737-400: \$170,000; Tu-204: \$260,000; 757-200SF: \$200,000; A310-300: \$230,000

Annual insurance cost: 727-100F: \$10,000; 727-200F: \$20,000; 737-300: \$120,000; 737-400: \$140,000; Tu-204: \$350,000; 757-200SF: \$220,000; A310-300: \$230,000

however, have since renegotiated their lease rentals to lower levels. Aircraft that were purchased and converted direct by airlines will be locked into the same book depreciation rates. These, and debt repayments, could be higher than the lease rates used here.

Younger types will have high hull insurance costs. These are assumed to be 1% per year of hull value. Hull values are based on \$1 million for the 727-100F, \$2 million for the 727-200F, \$12 million for the 737-300, \$14 million for the 737-400, \$35 million for the Tu-204, \$22 million for the 757-200 and \$23 million for the A310-300.

Besides utilisation and lease rates, there are other inherent differences in the cost structures of European and US carriers. These are mainly illustrated by pilots' salaries, which are generally higher in the US. The 727s should have a cost disadvantage compared to their replacement candidates, since the 727s operate with a three-man crew.

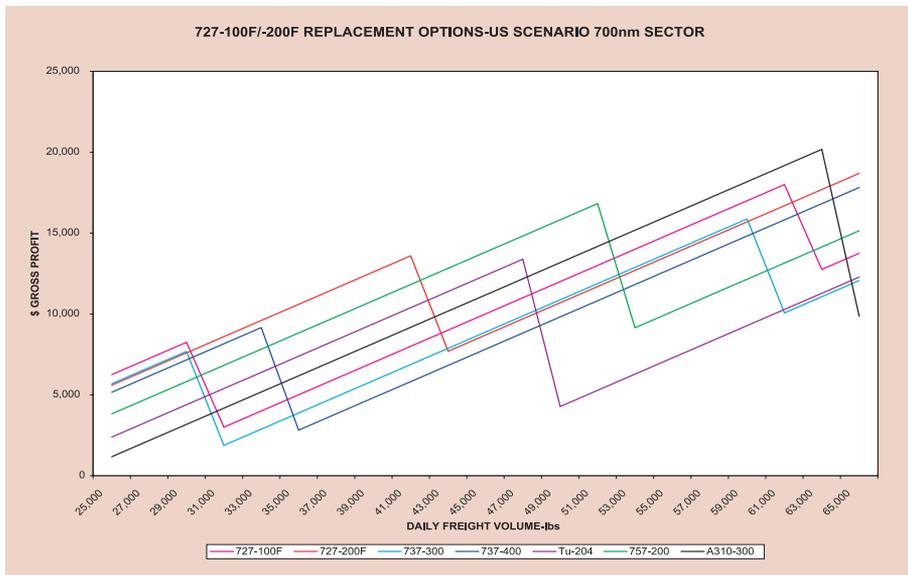
Pilots' salaries are increased by the additional crew costs of allowances, transport, training and subsistence. Annual flight crew productivity has an

impact, and is generally lower compared to daytime passenger operations. Annual flightcrew productivity is assumed to be 550FH per year. Annual crew costs for each aircraft are shown (see tables, this page & page 52).

The 727-100F/-200F will also be at a disadvantage because of higher fuel burn and maintenance costs compared to younger types. In the case of a 600nm trip, the 737-300 and -400 have 40% and 35% lower fuel burn than the 727-100F. The 757-200SF has a 30% lower fuel burn than the 727-200F. The A310-300's and 727-200F's fuel burns are similar. Fuel prices are high, and are assumed to be 90 cents per US gallon.

Assumptions for maintenance costs are shown (see tables, this page & page 52), and engine inventory costs have also been included. These are high for younger types. Engine inventory costs are a mixture of depreciation for owned spare engines and lease rentals and reserves for short-term leased engines for a fleet of 10 aircraft. Although these are high for modern types, the cost of engine inventory is small as a portion of total trip costs.

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OPERATING COST ASSUMPTIONS FOR AIRCRAFT ON US 700NM ROUTE

Annual utilisation: 1,200FH, 650FC

Fuel price: 90 cents per US Gallon

Maintenance costs: 727-100F/-200F: \$1,360/FH; 737-300/-400: \$950; Tu-204: \$1,100/FH; 757-200SF: \$1,070/FH; A310-300: \$1,800/FH

Annual crew costs: 727-100F: \$310,000; 727-200F: \$310,000; 737-300: \$219,000; 737-400: \$225,000; Tu-204/757-200SF: \$262,000; A310-300: \$287,000

Annual crew productivity: 550FH

Annual engine inventory costs: 727-100F/-200F: \$15,500; 737-300/-400: \$50,000; Tu-204/757-200SF: \$69,000; A310-300: \$101,000

Monthly lease rentals: 727-100F: \$30,000; 727-200: \$50,000; 737-300: \$150,000; 737-400: \$170,000; Tu-204: \$260,000; 757-200SF: \$200,000; A310-300: \$230,000

Annual insurance cost: 727-100F: \$10,000; 727-200F: \$20,000; 737-300: \$120,000; 737-400: \$140,000; Tu-204: \$350,000; 757-200SF: \$220,000; A310-300: \$230,000

European scenario

The 727-100F and 737-300 have close freight capacities and trip costs. They generate similar gross profits (see chart, page 51). The 737-300's lease and insurance trip costs are about \$1,500 higher than the 727-100F's, but this is offset by the 737-300's operating efficiencies. The 737-300 at a lease of \$150,000 per month can provide an economic alternative to the 727-100F.

The 737-400 has a trip cost about \$300 higher than the 727-100F. This makes the 737-400 only viable when freight volumes are too high for a single 727-100 or 737-300 trip. This gap will be closed when 737-400s become available at lower values and lease rates.

The 737-400's trip costs and gross profit performance are also similar to the 727-200's (see chart, page 51). The implications are that the 737-400, with a lease rate of \$170,000 per month, is a suitable alternative to the 727-200 when freight volumes are less than 35,000lbs.

Overall, this indicates the 737-300 and -400 are an economic alternative to the 727-100F/-200F, where freight

volumes are not high enough to make full use of the 727-200F's capacity.

The 757-200SF has about \$1,000 higher cash operating costs per trip than the 727-200F. This gap will reduce as the 727-200F ages and suffers from increasing maintenance costs, and values and lease rates of 757-200s continue to decline. The 757-200SF already has a lower cost per lb of freight capacity. Moreover, the gap in trip cost will be lower than shown here for 727-200Fs that were acquired and converted direct by an airline four to nine years ago.

The Tu-204's capacity falls between the 727-200F and 757-200SF. The Tu-204 also has high finance and insurance charges, since it is the only new aircraft in the analysis. This makes the Tu-204's gross profit performance lower than the 757-200SF's. The narrow range of daily freight volume where the Tu-204 fits in between the 727-200F and 757-200SF and the Tu-204's relative economic performance means the 757-200SF is probably the preferred option for daily freight volume that exceeds the 727-200F's capacity (see chart, page 51). As the gap closes between the 727-200F's

and 757-200SF's trip costs, the 757-200SF will have the best gross profit performance for freight volumes between about 34,000lbs and 52,000lbs. The 757-200SF is also more economic than two 727-100F trips over these daily freight volumes (see chart, page 51).

The A310-300 is the most economic option for high freight volumes, and outperforms two daily trips of all other aircraft types. This is despite the A310-300's high weight, which will have an impact on its fuel burn performance, maintenance costs and weight-related navigation and landing charges.

US scenario

In the US scenario the 727-100F has almost the same trip cost as the 737-300, and the 737-400 has a slightly lower trip cost than the 727-200F.

As in the European scenario, the 737-300 and -400 present themselves as a suitable alternative to the 727-100/-200F on routes where daily freight demand is less than the 727-200F's full capacity.

The 757-200SF has higher trip costs than the 727-200F, as in the European scenario. The 757-200SF, however, is able to generate lower cost per lb for a full payload capacity. This shows, as in the European scenario, that the 757 is the more economic option on routes where freight volumes exceed the 727-200F's capacity. In this scenario the 727-200F's trip costs are about \$700 lower than the 757-200SF's. This gap will close as the 727's maintenance costs continue to rise and the 757's values rates fall. A rise of \$100 per FH in the 727-200F's maintenance costs and either a 5-10% drop in the 757's lease rentals or increase in utilisation would close this gap to zero.

This gap will already be smaller for 727-200's that were acquired and converted by airlines in the past three to eight years, since these aircraft will have depreciation rates or debt repayments higher than the lease rates used.

Many freight carriers may use the 757-200SF on longer routes than the 727-200F to begin with, and so generate higher utilisations. The 757-200 would then have lower trip costs and higher gross profit performance than the 727 for an equal volume of freight. As Lapointe at Kelowna says, "The 757's capital cost is too prohibitive at current levels, but we would consider it at lower market values or if we could generate 10FH per day compared to our current 5FH per day."

The 757-200SF is also more economic than two daily trips made by the 727-100F, 737-300 and 737-400.

The Tu-204's high lease costs make it less attractive than the 757. A single A310-300 trip is again more economic than two daily trips by smaller aircraft for the highest freight volumes. **AC**