

With the 727 freight conversion market now almost dead and several airlines considering its replacement, up to six agencies are developing 737 & 757 freighter conversion modifications. What is the market capacity for a new generation of converted narrowbody aircraft?

What is the market requirement for 20-35 ton freighters?

The past year has seen several companies emerge with proposals for 737 and 757 passenger to freighter conversions, which are in addition to the 757-200SF offered by Boeing services.

Some prospective modifications agencies are more advanced than others with the progress of their supplemental type certificates (STCs). There are at least three companies that have or are aiming to obtain an STC for 737-300/-400 conversions, and another three that have an STC for the 757. The target market for these aircraft is primarily 727 replacement for the express package operators and more capacity for traffic growth with the same airlines.

In addition to the 737 and 757, there are other types that could satisfy this sector of the market. EADS-EFW has already begun work on an A320/21 conversion, which will become economic in the next 5-10 years. Additionally, the westernised Tu-204 may receive western certification by the end of 2002.

With a large number of conversion agencies, is the potential market for 737 and 757 conversions, and other aircraft of a similar size, large enough for all potential modification agencies?

Narrowbody freighter fleet

There are 390 727-100F/-200Fs in operation. A further 100 737-200Fs/-300Fs are also in service, along with 96 DC-9s. The majority of these 600 aircraft is more than 20 years old, and represents a large replacement opportunity. This market will be contested by the 737-300/-400, 757, A320/21 and Tu-204.

The possibility of growth also exists. The majority of airlines operating these older aircraft are located in the US and West Europe. Boeing's World Air Cargo

Forecast estimates compound annual growth rates of 6.4% for global freight traffic. This could result in a trebling of capacity over the next 20 years, although the fleet would grow by a smaller factor due to the utilisation of larger aircraft.

There would therefore not necessarily be a market for additional aircraft in the 737-200/DC-9 to 727-200 size category to cope with traffic growth. Some airlines, such as FedEx, have used A310-200s to replace the 727-100F on a two-for-one basis, and similar strategies could be repeated by other airlines.

Candidate payloads

There are wider differences in the specifications of freight aircraft compared to passenger types. This is especially the case with express package operations, which depend primarily on volume rather than structural weight capacity.

Express package freight has a typical low density of 6.5lbs per cubic foot. The implications of this are that most aircraft 'bulk out' before 'grossing out', that is their volume is filled before structural payload is reached. This could mean that express package carriers will require replacement candidates with similar or larger volumetric capacity than the types they currently operate. The main driver of this will be the need to cater for some growth, but also to provide some flexibility.

The payload characteristics of the older and replacement candidate aircraft are summarised (see table, page 46). These are based on the number of maindeck containers carried. The standard type used by the 727-100/-200 and 737 are the 125-inch by 88-inch by 82-inch, with an internal volume of 458 cubic feet. The 727-100 can accommodate nine of these, while the

727-200 takes 12. This gives the two aircraft maindeck containerised volumes of 4,122 cubic feet and 5,496 cubic feet. With a packing density of 6.5lbs per cubic foot, the two aircraft have volumetric payloads of 26,793lbs and 35,724lbs. Underfloor space for freight carriage can also be used, but airlines use pallets or bags, since container loading systems are heavy.

The 737-200 has space for seven of the same containers used by the 727, which provide the 737-200 with a volume of 3,206 cubic feet and a volumetric payload of 20,839lbs (see table, page 46).

The DC-9 is also used in a few freight fleets, with the largest operated by Airborne Express (ABX). It will be replaced at some point. Although ABX does not operate freight aircraft with conventional freight loading systems, it will now take some 767s with conventional freight doors, which is an indication that it may be prepared to take smaller conventional freight aircraft to replace the DC-9 in later years.

The 737-300 and -400 replacement candidate aircraft are smaller than the 727-200. The 737-300 can take eight containers, providing 3,664 cubic feet, and the 737-400 holds nine, providing 4,122 cubic feet. These provide the 737-300 and -400 with respective volumetric payloads of 23,816lbs and 26,793lbs (see table, page 46).

The 757-200SF, offered by Boeing, holds 14 of the same containers, giving 6,412 cubic feet of space, just 916 cubic feet more than the 727-200. The variant has a volumetric payload of 41,015lbs (see table, page 46).

Other proposed 757 conversion programmes, including the one offered by Structural Integrity Engineering (SIE) tentatively offer 15 container spaces,

Aircraft type	737-200	727-100	727-200	737-300	737-400	757-200	A320	A321	Tu-204
Number of maindeck 125/88/82 containers	7	9	12	8	9	14/15	10	13	13
Containerised volume (cubic feet)	3,206	4,122	5,496	3,664	4,122	6,310/ 6,870	4,580	5,954	5,954
Volumetric payload lbs (packing at 6.5lbs/cu ft)	20,839	26,793	35,724	23,816	26,793	41,015/ 44,655	29,770	38,701	38,701
Build costs									
Conversion & freight handling system				2.2-3.0	2.2-3.0	4.5/8.5	3.5	3.5	
Heavy C/D check				1.5	1.5	1.0	1.5	1.5	
Component changes				0.2	0.2	0.6	0.2	0.2	
1 engine shop visit				1.5	1.5	1.5	1.5	1.5	
Sub-total				5.4-6.2	5.4-6.2	7.6/11.6	6.7	6.7	
Market value				8.0	10.0	12.0-15.0	15.0	18.0	
Total build cost/list price-\$ million				13.4-14.2	15.4-16.2	19.6-26.6	21.7	24.7	38.5
Monthly lease rate factor %				1.3-1.5	1.3-1.5	1.1-1.3	1.0-1.1	1.0-1.1	0.9
Monthly lease rate-\$K/month				175-215	200-245	216-345	217-239	247-272	346

providing 6,600 cubic feet and a payload of 44,655lbs (see table, this page).

Halfway between the 727-200 and 757-200SF is the Tu-204, with 13 container positions, providing 5,954 cubic feet and volumetric payload of 38,701lbs (see table, this page).

While the A320's and A321's market values are still too high to make conversion economic, they would use the same maindeck containers as the 727/737/757 and Tu-204. The A320 and A321 could take 10 and 13 of these containers, providing 4,580 and 5,954 cubic feet and volumetric payloads of 29,770lbs and 38,701lbs (see table, this page).

Fleet options

The A321, Tu-204 and 757-200 are the only candidates to offer more volume than the 727-200. The 737-400 and A320 offer the same and more volume than the 727-100, while the 737-200/-300 is smaller than the 727-100.

This raises the issue of suitable candidates to replace aircraft currently in use. The main problem is that there is no aircraft capable of accommodating the same number of maindeck containers as the 727-200, which will force airlines to make a compromise between a single

larger type, or a mix of smaller and larger types. A mixed fleet is more likely for those airlines operating 727-100s or 737-200s alongside 727-200s.

"Small package aircraft often bulk out first because of light density material. This means airlines are unlikely to go down in size from a 727-200 to a 737 or other smaller aircraft," argues Jules Rondpierre, executive vice president of marketing and sales at Sirocco Aerospace. "This is because they require more volume for growth as well as flexibility. Express carriers guarantee delivery and if they have a full aircraft they have to operate another just to carry some incremental payload. Most express carriers want more space, and so will go for larger types, such as the A321, Tu-204 and 757."

Chris Damianos, senior vice president cargo programmes at GECAS, expects some to select a mixed fleet. "Many are not using the 727-200's full volume, and so could downsize some of their aircraft to a 737-300/-400. Airlines may also make adjustments to their operation and operate a fleet of aircraft both larger and smaller than the 727-200. The 757 could be used for busier routes, and the 737 for lighter ones," says Damianos.

The options for single larger types have been stated. One combination of

smaller and larger types is the 737-300/-400 mixed with the 757-200, or possibly the Tu-204. Another is the A320 and A321.

Market forecasts

Various forecasts have been made for the freighter aircraft market in the 737 to 757 category.

Consultants SH&E conducted one for Precision Conversions, which is developing a freighter modification for the 757. SH&E has estimated that the 30-50 ton market, which includes the A321, 757 and Tu-204, will be about 600 units. This was made on the basis of a conservative compound growth rate of 2% per year. These 600 aircraft are split between 380 for replacement, primarily the 727, and another 220 for growth over 20 years.

GECAS has taken the strategic step of making a core business of converting aircraft into freighters and then leasing them. The lessor has a stream of aircraft coming off-lease and the ability to finance their conversion and make them serviceable as freight aircraft. It has concluded agreements with Bedek Aviation to convert 737-300/-400s and 767s. GECAS has finalised its 737 conversion programme and the first

The 727 replacement market is limited to about 600 aircraft operated by a few major airlines. Some aircraft will be replaced by larger types, while growth will stimulate demand for aircraft of a similar size. This limits the market for 737 and 757 conversions, which are currently being developed. A few major 727 operators may select alternative types, which could severely limit the market for 737 & 757 freighters.

aircraft will be converted by Bedek in 2002, while Bedek's 737 conversion STC is going through the final stages of development. "There are about 685 aircraft with a 20 ton capacity in service," says Damianos. "These are 727-100F/-200Fs, 737-200Fs and DC-9s. We do not expect fleet growth in this area, since this will be satisfied by larger types. We expect replacement of 90% of these older types. This is still substantial, since it equates to about 30 units each year. There is still the possible upside for growth from the turboprop sector."

Boeing's market forecast estimates the smaller freighter fleet, including aircraft less than 30 tons, to increase from 670 to 930 aircraft. The large narrowbody category is expected to expand from the current 300 to 390 aircraft, due to a large number of DC-8s and 707s being replaced by medium-sized widebodies.

This means that there will be a market for both replacement and growth in the two size categories. About 600 of the aircraft less than 30 tons and all of the 170 707s and DC-8s will be replaced over this period. The fleet of aircraft less than 30 tons will have a net growth of 260 units, meaning that the market will be about 860 aircraft over 20 years, or about 45 each year.

On the basis of the 30-50 ton category increasing by 90 units, there will only be a market for about 220 additional aircraft in this category.

This forecast includes all global regions. China, for example, will provide one of the highest growth rates and largest markets over the next 20 years. "Freight traffic is expected to grow at 9% annually, and the market is expected to be the world's second largest after the US in 20 years," says Rondpierre.

Opinions regarding the development of the narrowbody freighter market therefore vary widely, particularly in relation to the aircraft expected to replace the largest number of 727-200s and the type to be used to accommodate growth.

Another factor will be which aircraft are used to replace the 707s and DC-8s. The majority is likely to be replaced by smaller widebody types, as has already been the case.

The largest influence on a type's success is the fleet selections made by FedEx and United Parcel Service (UPS).



UPS has already begun retiring its 727-100s and shows no signs of selecting a narrowbody in the 20-50 ton range to replace it. FedEx has 135 727-100/-200s in operation. The airline may replace some of these with widebodies, leaving a smaller number to the narrowbody competition. FedEx may also leave 727 replacement for another 5-10 years, and later select the A320/21 or even a new aircraft like the Tu-204, severely reducing the 737 and 757 conversion markets.

Most forecasts predict that 70% of the demand for all aircraft will be accounted for by modified passenger aircraft. "This forecast has probably been made without considering the issue of aircraft such as the Tu-204," comments Rondpierre. "We have a price advantage with the aircraft, since its list price is \$38.5 million, and this has to be considered against the build cost and age of a converted 757 freighter."

Conversion options

There are currently three main 737-300/-400 and three 757 conversion options.

Acquiring a freight modification STC has been made more difficult following the fatigue and crack problems of 727s and 747s converted under various STCs.

STCs for the modification of these aircraft were given by individual jurisdictions of the Federal Aviation Administration (FAA). The process of issuing STCs has now changed. New freight modification STCs must be approved by the FAA's national office in Washington DC, and all aircraft registered in the US must have been

modified with such an STC. It is almost impossible for new STCs to be approved without an analysis of the modification's structural integrity and the effect of loads on the aircraft's structure by use of a finite element modelling system (FEM). The FEM must be developed by the modification agency, which requires structural data on the wing and fuselage. Agencies will be forced to undertake lengthy and expensive analysis.

Two 737-300/-400 modification providers are Pemco and Bedek Aviation. While structural payloads for the same type will vary, volumetric payloads will be similar or equal if the number and size of containers that can be carried are equal. Another 737 conversion agency is AEI.

Cost of conversion and installation of a freight handling system will be a main influence on build cost and subsequent lease rate. The main constituents of build cost are aircraft purchase, bridging and possibly heavy check maintenance, component repairs, possible engine maintenance, modification to freighter, installation of freight handling system and weight upgrades.

The cost of these elements is summarised (see table, page 46). Cost of conversion and freight handling system provided by Pemco is in the region of \$2.3 million range for the 737-300/-400. Pemco had an STC for 737-300/-400 conversions 10 years ago, which had problems with cracks around the door area, resulting in airworthiness directives requiring inspections. Pemco has re-designed its conversion and used new technology to do an FEM analysis to get a new STC. The FAA will issue this new



STC at the end of March 2002.

Boeing's modification is expected to cost \$3.0 million if launched.

There is currently only the Boeing modification for the 757-200, priced at \$8.5 million, which includes the freight handling system. All independent modification providers are aiming to be competitive against Boeing. SIE and Precision Conversions will offer their conversions at a list price of \$4-5 million, which will include a freight handling system. SIE's conversion will have a freight handling system provided by either AAR, Ancra or Tel Air.

SIE will manufacture kits and subcontract the conversion work to a maintenance facility, with SIE engineers on site monitoring the modification. SIE's goal is to achieve a modification of higher quality than the original equipment manufacturer's own conversion. SIE expects to have its STC approved by the second quarter of 2003.

EADS-EFW is proposing to offer conversions and freight handling system for the A320 and A321 at about \$3.5 million, which is low in relation to their size versus the 737 and 757 and the cost of their modifications.

Aircraft market value or purchase cost combined with modification and bridging maintenance costs determines total build cost. To make an economic case for conversion, lessors acquiring and converting aircraft will need to realise a lease rate factor of 1.1-1.3% per month for aircraft that are converted at 12-16 years old.

Market values are hard to predict, since few aircraft are being sold and those that are will exchange at distress values.

Large numbers of 737-300s and -400s are available, which are likely to increase with new 737NGs and A320s being offered at lease rates lower than \$200,000. Values of 737-300s will have now fallen to the \$8 million and -400s to \$10 million. Values of 757s are hard to assess, since only a small number are available and airlines are not showing signs of retiring significant numbers. When aircraft are retired values are likely to be soft, since the only secondary market will be freight conversion and the low lease rates of new passenger aircraft will have a strong influence. Values may be as low as \$12-15 million.

No A320s or A321s are available, and these have the strongest residual value retention. Values are hard to predict, but may be as low as \$15 million for the oldest A320s and \$18 million for the lightest and oldest A321s.

These values would generate build costs of \$13-14 million for the 737-300, \$15.4-16.2 million for the 737-400, \$19.6-26.6 million for the 757-200, \$21.7 million for the A320 and \$24.7 million for the A321 (see table, page 46).

The values and consequent possible build costs of older aircraft with the lowest values generate monthly lease rates of \$175,000-215,000 for the 737-300 and \$200,000-245,000 for the -400. These lease rates would provide the aircraft with a unit cost per available ton-mile close to the 727-100F operating a low utilisation operation for express packages (see *Are the 737-200 & -300/-400 ready for freight conversion?* *Aircraft Commerce*, June/July 2001, page 11).

The 757 converted with an independent modification will have a

Values of 737-300s have recently been hit by the downturn in traffic and unprecedentedly low financing rates of new narrowbodies. Market values of 737-300s have now reached levels which make conversion economic.

lease rate in the region of \$220,000 per month. It is expected that lease rates for the 757 freighter would have to be in the region of \$275,000-300,000 for most potential lessees to take the aircraft (see *757-200 on the brink of a new life*, *Aircraft Commerce*, August/September 2001, page 13). The combination of current values and a competitive conversion programme would therefore make the 757 economically attractive. Aircraft modified under the Boeing programme would have a higher lease rate of \$345,000, making the aircraft too expensive for many operators. Even with a fall in market values, lessors and airlines would still have the option of a cheaper conversion with an independent agency.

The A320 and A321 purchased for conversion at the expected market values would have monthly lease rates averaging \$225,000 and \$265,000. In relation to their containerised volumetric capacity, the A320 and A321 will have competitive economics compared to the 737-300/-400 and 757-200. This indicates that conversion of the first A320 and A321 may be closer than expected.

The probable lease rates for the 757 and A321 have to be considered against the lease rate of about \$340,000 generated from the list price for the Tu-204. Actual lease rate will probably be lower as a consequence of price discounts. One major factor in the Tu-204's favour is that it is a new aircraft. With express package operations generating low levels of utilisation, aircraft can operate for up to 40 years. This would allow aircraft to be fully depreciated over the first 15-20 years, and then operated with zero finance charges for their remaining lifespan.

Sirocco Aerospace expects the Tu-204 to receive Joint Airworthiness Authority (JAA) certification by the end of 2002. "The FAA usually requires a customer to commit to the aircraft first before it will proceed with the certification process," explains Rondpierre. "We will therefore get JAA certification first. Once this is achieved it is relatively easy to get FAA certification. We also expect to certify the aircraft in China, which basically requires a validation of the Russian certification. We have already started this process, and it may only take a few months. It is also relatively easy to certify Russian aircraft on the Indian sub-continent." 