Acquiring freighters needs careful examination. The costs of aircraft acquisition, modification to freighter and bridging maintenance have to be assessed against future economic performance and payload capacity. All narrowbody freighter conversion programmes have to be considered.

The costs of acquiring narrowbody freighters

The reduced supply of available used passenger aircraft in recent years has increased their market values. This could change quickly with the financial difficulties facing US major carriers. All the costs of acquiring a used aircraft, converting it to freighter, installing a cargo loading system, and performing bridging and other maintenance are examined here for narrowbody freighters. The payload characteristics and features of the conversions available are also examined.

Narrowbody freighters

The 737-300 and 757-200 have been acquired in large numbers via passenger-to-freighter programmes in recent years. There are also two certified passenger-to-freighter conversion programmes for the 737-400, and a third in development. These types have displaced the 727-100/-200 and 737-200 as the most popular narrowbodies to convert to freighters. Aeronautical Engineers Inc (AEI) is still converting a small number of 737-200s.

EADS-EFW has formed a joint venture with Airbus, Irkut and UAC called Airbus Freighter Conversion GmbH to offer freighter conversions for the A320 and A321. The first aircraft are due to enter service in 2011/12.

The A320 and A321 have increased to six the number of narrowbodies from which freight carriers can choose.

Payload capacity

The payload capacity of these aircraft depends on structural payload capacity and available volume for carrying freight.

Each type has several maximum take-off weights (MTOW). Most freight operators will increase their aircraft's MTOW by a 'paper' certification change. However, the MTOW does not affect the payload capacity of any aircraft type, unless it is operating at the extreme end of its payload-range profile.

The gross structural payload of the aircraft is defined as the maximum zero fuel weight (MZFW) minus the operating empty weight (OEW), which excludes the tare weight of the freight containers.

The net structural payload is the gross structural payload minus the tare weight of containers, or unit load devices (ULDs) or pallets. This is affected by the number and type of containers or pallets used on a particular mission.

Payload carriage

The available freight volume is the combined volume of the containers or pallets used. All 737 freighters use these on their maindecks, but have empty bulk volume space in their underfloor areas.

The 757-200 also uses containers or pallets on its maindeck. The 737-200/-300/-400 and 757 have the same fuselage cross-section and so use maindeck ULDs with the same profile to match the shape and contour of the maindeck cabin.

The ULD that most closely matches the 737's and 757's inner fuselage profile is the 125-inch wide container. These are either 88 inches or 96 inches deep, with more of the 88-inch containers able to fit in a particular cabin length than the 96-inch ULDs. Both types have a contoured top to match the 737/757 fuselage shape, and are 79 inches high at the apex. The 88-inch X 125-inch container has an internal volume of 440 cubic feet and tare weight of 476lbs.

The 88-inch deep ULD is the most commonly used, with the 96-inch device being used to interline with widebodies.

A third container for the 737/757 is the 108-inch wide ULD. This is 88 inches deep and 79 inches tall. Its narrower width means it does not fully utilise the profile of the maindeck cabin, so it is less efficient than either of the 125-inch wide containers, and is only used if its operator has to interline with smaller freighters, such as the BAE 146.

The three 737 models also use other smaller ULDs at the aft of their maindecks, because of the tapering of their fuselages, to provide a small amount of additional available freight volume.

The A320 and A321 have a wider fuselage cross-section than the 737 and 757, but all four aircraft use the same 88-inch X 125-inch ULD.

The A320 and A321 are the only narrowbodies to use ULDs in their underfloor space: the LD3-45W variant of the LD3, with an internal volume of 127 cubic feet and tare weight of 165lbs.

All six types are analysed here on an equal basis, using the 125-wide and 88-inch deep maindeck ULD, with an internal volume of 440 cubic feet and tare weight of 476lbs.

737-200

Several passenger-to-freighter programmes have been available for the 737-200. AEI is still marketing its modification, and is currently converting aircraft at its sister company Commercial Jet's facility in Miami.

The 737-200 is an old aircraft with groups of ageing-aircraft airworthiness directives (ADs) that have compliance thresholds varying from 8,000 flight cycles (FCs) to 75,000. Each group of ADs has several service bulletins (SBs) that must be terminated by the threshold. Most will have been. One group of 56 SBs has a compliance threshold of 75,000FC, but only 27 of these have to be performed on aircraft higher than line number 634. The inputs required to carry out these SBs will put most operators off keeping these aircraft, but the threshold

737-200 & 737-300 PASSENGER-TO-FREIGHTER MODIFICATION SPECIFICATIONS

Aircraft type	737-200Adv	737-300	737-300 9G net/ 9G barrier	737-300 9G net/ 9G barrier
Converter	AEI	AEI	Bedek Aviation	Pemco
MZFW-lbs	95,000	109,000	109,600	109,600
OEW-lbs	60,000	62,000	66,500/67,300	65,965/66,400
Gross structural payload-lbs	35,000	44,000	43,100/42,300	43,635/43,200
Maindeck containers	7 X 88/125 plus 1 X 88/108	9 X 88/125	8 X 88/125 plus 1 X 60/96	8 X 88/125 plus 1 X 66/88
Underfloor capacity-cu ft	875	1,068	1,068	1,068
Container tare weight-lbs	3,332	4,284	4,038	4,038
Net structural payload-lbs	31,668	39,716	39,062/38,262	39,597/39,162
Total volume-cu ft	4,307	5,028	4,740	4,740
Maximum packing density-lbs/cu ft	7.3	7.9	8.2/8.1	8.3/8.2
Volumetric payload @ 7lbs/cu ft	31,149	35,196	33,180	33,180

737-400 PASSENGER-TO-FREIGHTER MODIFICATION SPECIFICATIONS

Aircraft type	737-400	737-400 9G net/ 9G barrier	737-400 9G barrier
Converter	AEI	Bedek Aviation	Pemco
MZFW-lbs	113,000/117,000	114,000/117,000	117,000
OEW-lbs	67,000/68,000	69,800	69,860
Gross structural payload-lbs	46,000/49,000	44,200/47,200	47,140
Maindeck containers	10 X 88/125	9 X 88/125 plus 1 X 88/125/64	10 X 88/125
Underfloor capacity-cu ft	1,373	1,373	1,373
Container tare weight-lbs	4,760	4,684	4,760
Net structural payload-lbs	41,240/44,240	39,516/42,516	42,379/42,280
Total volume-cu ft	5,773	5,683	5,773
Maximum packing density-lbs/cu ft	7.1/7.6	6.9/7.5	7.3
Volumetric payload @ 7lbs/cu ft	40,411	39,781	40,411

of 75,000FC is high.

The 737-200 has the benefit of the lowest market value of all the six types. Market values for the youngest, highest gross weight hushkitted 737-200s are up to $1.5 million. Including cargo loading system, AEI's freighter conversion costs $1.7 million, compared to $5-6 million for older passenger 737-300s.

AEI has converted aircraft in recent years for Air India and Blue Dart.

Following conversion, the aircraft can accommodate seven 88-inch X 125-inch ULDs on its maindeck, plus one narrower 88-inch X 108-inch ULD at the rear. These eight ULDs give a containerised volume of 3,432 cubic feet, and a tare weight of 3,332lbs. The underfloor freight area provides an additional 875 cubic feet, giving a total freight volume of 4,307 cubic feet *(see table, this page)*.

Following conversion, the -200 has an MZFW of 88,000lbs and the -200Adv 95,000lbs. The OEW, without tare, for these two aircraft averages 60,000lbs.

This gives the 737-200Adv a gross structural payload of 35,000lbs.

After ULD tare weight is deducted, the 737-200Adv has a net structural payload of 31,668lbs. It has a maximum packing density of 7.3lbs per cubic foot.

737-300

Bedek Aviation, Pemco and AEI offer passenger-to-freighter conversion programmes for the 737-300. The payload characteristics and other features of each are shown *(see table, this page)*.

The Bedek Aviation 737-300 conversion has three main types: the freighter with either the 9G cargo net or 9G rigid barrier; and the Quick Change (QC) model. The two freighter models are the principal variants analysed here.

The 9G rigid barrier gives the aircraft a higher OEW than the 9G cargo net. While this reduces structural payload, it has the advantage of allowing loading crew to be carried between the flightdeck and the cargo hold.

Following conversion using Bedek's programme, the 737-300BDSF has an MZFW of 109,600lbs. The OEW of the aircraft with a 9G restraining net is 66,500lbs, and with a 9G rigid barrier is 67,300lbs. This gives these two variants gross structural payloads of 43,100lbs and 42,300lbs *(see table, this page)*.

The 737-300 accommodates eight of the standard 88-inch X 125-inch wide maindeck ULDs, plus a single smaller container at the rear of the maindeck that is 61 inches X 96 inches wide. This small container has an internal volume of 152 cubic feet and a tare weight of 230lbs.

The ULDs provide 3,672 cubic feet and have a tare weight of 4,038lbs, giving the aircraft a net structural payload of 39,062lbs and 38,262lbs *(see table, this page)*. The aircraft also has an underfloor freight volume of 1,068 cubic feet. Using all available freight volume gives a total of 4,740 cubic feet, providing a maximum packing density of 8.2lbs and 8.1lbs per cubic foot.

Bedek's list price for the conversion is $2.5-2.7 million, including cargo loading system.

AEI's 737-300 modification provides an MZFW of 109,000lbs and an OEW of 62,000lbs, giving it a gross structural payload of 44,000lbs.

The aircraft accommodates nine 88-inch X 125-inch ULDs, providing a containerised maindeck volume of 3,960 cubic feet. Added to the underfloor capacity of 1,068 cubic feet this takes the aircraft's total volumetric capacity to 5,028 cubic feet *(see table, page 60)*.

The tare weight of the nine ULDs provides the aircraft with a net structural payload of 39,716lbs *(see table, page 60)*. Together with the available freight volume, the aircraft has a maximum packing density of 7.9lbs per cubic foot.

The list price of AEI's conversion, including the cargo loading system, is $2.3 million.

The third major 737-300 conversion programme is available from Pemco, and gives the aircraft an MZFW of 109,600lbs. There are three variants: a pure freighter with a 9G cargo net; a pure freighter with a 9G rigid barrier; and a QC version. The two pure freighters are analysed here. The 9G net aircraft has an OEW of 65,965lbs, and the rigid barrier aircraft an OEW of 66,400lbs. They have gross structural payloads of 43,635lbs and 43,200lbs *(see table, page 60)*.

The aircraft has the same maindeck ULD configuration as the Bedek Aviation conversion, giving the aircraft a maindeck containerised volume of 3,672 cubic feet and a total volume of 4,740 cubic feet.

The nine containers on the maindeck have a tare weight of 4,038lbs, leaving the 9G cargo net variant with a net structural payload of 39,597lbs, and the rigid barrier variant a net structural payload of 39,162lbs *(see table, page 60)*. The total available freight volume allows the aircraft a maximum packing density of 8.35lbs and 8.26lbs per cubic foot.

737-400

AEI, Bedek Aviation and Pemco are developing passenger-to-freighter conversion programmes for the 737-400.

The AEI conversion offers two MZFW options of 113,000lbs and 117,000lbs. After conversion the aircraft will have average OEWs of 67,000lbs and 68,000lbs, giving gross structural payloads of 46,000lbs and 49,000lbs.

The aircraft will accommodate 10 88-inch X 125-inch maindeck ULDs for a containerised maindeck capacity of 4,400 cubic feet. Underfloor volume will take total capacity to 5,773 cubic feet.

The tare weight of the 10 containers is 4,760lbs, leaving net structural payloads of 41,240lbs and 44,240lbs. The two variants therefore have maximum packing densities of 7.1lbs and 7.6lbs per cubic foot *(see table, page 60)*.

AEI's 737-400 modification has been awarded its supplemental type certificate (STC), and costs $2.9 million.

The Bedek modification provides two MZFW options of 114,000lbs and 117,000lbs. The aircraft has a 9G rigid barrier at the front of the freight maindeck and an OEW of 69,800lbs. This results in a gross structural payload of 44,200lbs and 47,200lbs.

The maindeck can accommodate nine of the standard 88-inch X 125-inch ULDs plus a smaller container with the same base dimensions but a lower height of 64 inches. This has a capacity of 350 cubic feet and tare weight of 400lbs. These 10 containers provide a total containerised volume of 4,310 cubic feet and have a tare weight of 4,684lbs, giving a net structural payload of 39,516lbs and 42,516lbs *(see table, page 60)*.

The aircraft also has an underfloor capacity of 1,373 cubic feet, and a total freight volume of 5,683 cubic feet, giving a maximum packing density of 6.95lbs or 7.48lbs per cubic foot, depending on MZFW variant *(see table, page 60)*.

Bedek expects the STC for this modification to be issued in the second half of 2008, with a list price, including cargo loading system, of $3.0-3.2 million.

The Pemco modification for the 737-400 provides an MZFW of 117,000lbs. The aircraft has a 9G rigid barrier, and an OEW of 69,860lbs. This gives the aircraft a gross structural payload of 47,140lbs *(see table, page 60)*.

The 737-400 accommodates 10 of the standard 88-inch X 125-inch ULDs on its maindeck, giving it the same tare weight and containerised freight volume as the

757-200 PASSENGER-TO-FREIGHTER MODIFICATION SPECIFICATIONS

Aircraft type	757-200 RR/PW	757-200 RR/PW	757-200 RR/PW	757-200 RR/PW
Converter	Precision Conversions	Precision Conversions	Precision Conversions	Precision Conversions
MZFW-lbs	184,000	184,000	188,000/186,000	194,000/192,000
OEW-lbs	116,500/116,150	116,000/115,650	116,000/115,650	116,000/115,650
Gross structural payload-lbs	67,500/67,850	68,000/68,350	72,000/70,350	78,000/76,350
Maindeck containers	15 X 88/125	15 X 88/125	15 X 88/125	15 X 88/125
Underfloor capacity-cu ft	1,790	1,790	1,790	1,790
Container tare weight-lbs	7,140	7,140	7,140	7,140
Net structural payload-lbs	60,360/60,710	60,860/61,210	64,860/63,210	70,860/69,210
Total volume-cu ft	8,390	8,390	8,390	8,390
Maximum packing density-lbs/cu ft	7.2/7.2	7.2/7.3	7.7/7.5	8.4/8.2
Volumetric payload @ 7lbs/cu ft	58,730	58,730	58,730	58,730

Aircraft type	757-200 RR/PW	757-200 RR/PW
Converter	Alcoa-SIE	Alcoa-SIE
MZFW-lbs	184,000	188,000
OEW-lbs	117,364/116,764	117,364/116,764
Gross structural payload-lbs	66,636/67,236	70,636/71,236
Maindeck containers	14 X 88/125 plus AXY demi	14 X 88/125 plus AXY demi
Underfloor capacity-cu ft	1,790	1,790
Container tare weight-lbs	6,964	6,964
Net structural payload-lbs	59,672/60,272	63,672/64,272
Total volume-cu ft	8,210	8,210
Maximum packing density-lbs/cu ft	7.3	7.8
Volumetric payload @ 7lbs/cu ft	57,470	57,470

AEI-converted aircraft: 4,400 cubic feet and 4,760lbs.

The underfloor volume of 1,373 cubic feet takes total capacity to 5,773 cubic feet. The aircraft has a net structural payload of 42,380lbs and maximum packing density of 7.34lbs per cubic foot *(see table, page 60)*.

757-200

The two main passenger-to-freighter conversion programmes for the 757-200 are offered by Precision Conversions and Alcoa-SIE. Another is offered by Boeing.

These modifications differ mainly in the number of 88-inch X 125-inch ULDs on the maindeck. Precision Conversions' allows 15 of these ULDs, while Alcoa-SIE's and Boeing's allow14, plus a smaller container at the aft of the maindeck.

The specification weights of the 757-200 depend on whether Pratt & Whitney PW2000 or Rolls-Royce RB211-535E4 engines are installed. The RB211-535E4s are heavier which increases the OEW. There are several MZFW options.

Precision Conversions' modification received its STC in 2004. The aircraft has an MZFW of 184,000lbs as standard. This can be increased to 188,000lbs for the RB211-powered aircraft and 186,000lbs for PW2000-powered aircraft with a Boeing upgrade. These higher MZFW options are only available for aircraft from line number 210 onwards.

The RB211-powered aircraft have an OEW of 116,500lbs or 116,000lbs, providing gross structural payloads of 67,500lbs, 68,000lbs and 72,000lbs. The PW2000-powered aircraft have lower OEWs of 116,150lbs and 115,650lbs, giving them gross structural payloads of 67,850lbs, 68,350lbs and 70,350lbs *(see table, this page)*.

Precision Conversions is developing a programme to offer an MZFW of 194,000lbs for RB211-powered aircraft and 192,000lbs for PW2000-powered aircraft. This will increase payload by 6,000lbs *(see table, this page)*. This will be available by mid-2008.

The 15 ULDs provide a capacity of 6,600 cubic feet and have a tare weight of 7,140lbs. The underfloor compartment gives a further 1,790 cubic feet, taking the total capacity to 8,390 cubic feet.

The RB211-powered aircraft therefore have a net structural payload of 60,360-70,860lbs, depending on MZFW. Maximum packing density is 7.2-8.4lbs per cubic foot, depending on MZFW.

The PW2000-powered aircraft have a net structural payload of 60,710-69,210lbs, depending on MZFW option. Maximum packing density is 7.3lbs and 7.8lbs per cubic foot *(see table, this page)*.

Precision Conversions' list price for the modification is $4.65 million, including cargo loading system.

Alcoa-SIE's '14Plus' conversion uses a rigid 9G barrier, and can accommodate 14 standard ULDs plus a smaller 'demi' container at the rear of the maindeck.

The modification is available with the standard MZFWs of 184,000lbs and 188,000lbs. OEW with RB211-535E4 engines is 117,364lbs, and with PW2037 engines 116,764lbs. This gives the RB211-powered aircraft gross structural payloads of 66,636lbs and 70,636lbs, and the PW2000-powered aircraft gross structural payloads of 67,236lbs and 71,236lbs *(see table, this page)*.

This conversion provides a total containerised volume of 8,210 cubic feet, and maximum packing densities of 7.3lbs and 7.8lbs per cubic foot *(see table, this page)*.

The STC for the modification was issued by the Federal Aviation Administration in October 2006. STCs for Brazil and China are expected in May 2008. The OEW is likely to be lowered by 2,000lbs, so gross and net structural payloads will rise by the same amount. This will involve removing three of four passenger doors from each side of the aircraft, and other equipment. The modification's list price is $3.75 million, including cargo loading system.

A320F & A321F

Airbus Freighter Conversion is a joint venture to market passenger-to-freighter modifications for the A320 and A321. Certification of the A320 is expected at the end of 2011, and in 2012 for the A321. Including cargo loading system, the conversions will cost $4.1 million for the A320 and $4.6 million for the A321.

The aircraft accommodate 88-inch X 125-inch ULDs on their maindecks: 10 on the A320 and 13 on the A321, with the same cubic capacity and tare weights as those used on the 737 and 757.

The A320 and A321 also use LD3-45W containers in their lower decks. These have a unit tare weight of 165lbs and cubic capacity of 127 cubic feet.

The A320F has a total container tare weight of 5,915lbs and capacity of 5,289 cubic feet.

The A320-200F will have an MZFW of 137,780lbs and OEW of 88,180lbs, giving it a gross structural payload of 49,600lbs. Less tare weight, the aircraft has a net structural payload of 43,685lbs and has a maximum packing density of 8.3lbs per cubic foot *(see table, page 66)*.

The MZFW for the A321-100F is 153,210lbs, and 162,690lbs for the -200F. Both aircraft have an OEW of 98,100lbs, giving them gross structural payloads of 55,110lbs and 64,590lbs.

The A321F has a total tare weight of 7,838lbs and capacity of 6,990 cubic feet. This leaves the A321-100F with a net structural payload of 47,272lbs and packing density of 6.8lbs per cubic foot. The heavier -200F has a net structural payload of 56,752lbs and packing density of 8.1lbs per cubic foot *(see table, page 66)*.

Volumetric payload

These narrowbody freighters will be used for express package operations or to carry general freight. Express packages have a packing density of 7lbs per cubic foot, and general freight tends to be 8lbs.

Except the Bedek-converted 737-400 with a 9G cargo net and A321-200P2F, all aircraft analysed have a maximum packing density higher than 7lbs per cubic foot. Few, however, have a packing density of more than 8lbs per cubic foot. The volumetric payloads are shown at packing densities of 7lbs per cubic foot *(see tables, pages 60, 62 & 66)*.

The 737-200Adv's volumetric payload is 31,149lbs, while the AEI-converted 737-300's is 35,196lbs. This is 33,180lbs for the Bedek and Pemco variants, which have a smaller ninth container *(see table, page 60)*. All three 737-300 conversion variants have maximum packing densities of 8lbs per cubic foot, so will have higher volumetric payloads if they carry general freight of higher density.

The AEI and Pemco 737-400 variants both use 10 standard ULDs, and so have a volumetric payload of 40,411lbs. The Bedek variant uses nine ULDs, and so has a slightly lower capacity of 39,781lbs *(see table, page 60)*.

Precision Conversions' modified 757-200 has a payload of 58,730lbs at this packing density, regardless of the engine model or MZFW. The high MZFWs of 192,000lbs and 194,000lbs give maximum packing densities of 8.2lbs and 8.4 lbs per cubic foot *(see table, page 61)*, allowing heavier general freight to be carried at a high or even full load factor.

The Alcoa-SIE-converted aircraft have a lower volumetric payload of 57,470lbs at 7lbs per cubic foot; 1,260lbs less than Precision Conversions' variant.

The A320-200P2F has a capacity of

A320-200 & A321-100/200P2F PASSENGER-TO-FREIGHTER MODIFICATION SPECIFICATIONS

Aircraft type	A320-200P2F	A321-100P2F	A321-200P2F
MZFW-lbs	137,780	153,210	162,690
OEW-lbs	88,180	98,100	98,100
Gross structural payload-lbs	49,600	55,110	64,590
Maindeck containers	10 X 88/125	13 X 88/125	13 X 88/125
Lowerdeck containers	7 X LD3-45W	10 LD3-45W	10 LD3-45W
Container tare weight-lbs	5,915	7,838	7,838
Container volume-cu ft	5,289	6,990	6,990
Net structural payload-lbs	43,685	47,272	56,752
Maximum packing density-lbs/cu ft	8.2	6.8	8.1
Volumetric payload @ 7lbs/cu ft	37,023	46,833	48,930

37,023lbs, which is 3,000lbs less than the 737-400. The A321-100P2F has a low volumetric payload of 46,833 lbs, while the -200P2F's capacity is 2,000lbs higher at 48,930lbs *(see table, this page)*. The A321-200P2F's capacity is therefore 10,000lbs less than the 757-200F's.

Preparing for service

The acquisition cost of individual aircraft depends on their maintenance status, but all will be at varying stages in their base check cycles. Maintenance will therefore be needed to prepare them for service. All aircraft will have a base check performed during the conversion process, which may be used to bridge the aircraft onto a new maintenance programme. In many cases the heaviest check may be done to bring it to the beginning of a base check cycle, although this will be expensive and unnecessary unless the heaviest check is due two or three years after modification to freighter.

Base checks

The 737 has a system of seven C checks, with the C4 a semi-heavy check and the C7 the heaviest. An aircraft should be put through whichever of these is due next. The C4 consumes 5,000 man-hours (MH) and $125,000 in materials and consumables, taking the total cost to $375,000. A C7 is heavier, using 10,000MH and up to $250,000 in materials and consumables when an interior refurbishment is not included. The C4 is likely to be the minimum size of base check included at modification.

The 757 has a system of four checks. The C2 is an intermediate check, and the C4 the heaviest. The C2 consumes 4,500MH and $115,000 in materials, totalling $340,000. The C4 uses 5,000MH and $500,000 in materials and consumables, a total cost of $1.3 million. The checks have an interval of 18 months, so at least one will be required.

The A320/321 have an eight-check base maintenance cycle. The C4 and C8 are the two heaviest and are needed every 60 months. The C4 check will use 10,000MH and $300,000 in materials and consumables when an interior refurbishment is excluded, and the C8 17,500MH and $450,000. The aircraft will require at least the C4 check.

A new paint scheme will be required, adding 1,100-1,300MH and $110,000 in materials, costing $105,000-125,000.

Components

Landing gear overhauls are typically required every 8-10 years, so will only be required on a minority of aircraft. Typical market rates for exchange and overhaul are $250,000 for the 737-300/-400, $450,000 for the 757, and $350,000 for the A320/321.

All main wheel brake units will have to be overhauled, costing $80,000 for the 737, $320,000 for the 757, and $140,000 for the A320/321. A new set of tyres will cost $6,000-10,000 for each aircraft.

Thrust reversers are overhauled on an on-condition basis, and one unit on average will be required while the aircraft is being modified. The cost of a shop visit for a unit is $190,000 for the 737 and A320, and $280,000 for the 757.

The auxiliary power unit (APU) will need a shop visit, costing $150,000 for the 737-300/-400, $200,000 for the A320/321, and $300,000 for the 757.

Finally, $250,000-300,000 should be allowed to test and repair some rotable items. These airframe and component costs will total: $1.4 million for the 737-300/-400 if a C4 check is included in the conversion; $2.1 million for the 757 if a C2 check is included; and $1.9 million for the A320/321 if a C4 check is performed. This treats all aircraft on a half-life basis with respect to base checks.

Engine maintenance

Engine shop visits are required every 8,000-10,000 engine flight hours (EFH) for the 737-300/-400. Shop visits will cost $0.9-1.3 million, and a set of life limited parts (LLPs) $2.1 million.

RB211 shop visits for the 757 are needed on average every 17,000EFH and cost $3.5 million, while a full shipset of LLPs costs $2.8 million. PW2000s need workscopes every 13,000-19,000EFH, and have lower shop visit costs of $2.0 million. A shipset of LLPs costs $3.0 million.

Shop visits for the CFM56-5B and V2500-A5 series are needed every 11,000-19,000EFH, depending on rating and operation, and cost $1.4-2.3 million. LLP shipsets cost $1.8-2.2 million.

These engine shop visit and LLP replacement costs are high in relation to airframe and component maintenance costs. Even if they are not required during conversion, some level of maintenance on at least one engine is likely to be needed within a few years of modification. The condition of engines, and the timing and cost of likely maintenance must be reflected in the aircraft acquisition cost.

The engine-related cost for one shop visit on the CFM56-3 will average $1.1 million. This will be $3.5 million for an RB211-powered 757, $2.0 million for a PW2000-powered 757, and $1.9 million for an A320 or A321.

The remaining life of engine LLPs will affect the acquisition cost of the aircraft.

Excluding engine LLPs, the total cost of maintenance required to convert the aircraft to freighter will therefore be: $2.5 million for a 737-300/-400; $4.1-5.6 million for a 757, depending on engine type; and $3.8 million for an A320/321.

Aircraft acquisition

Strong demand for aircraft from the passenger sector has kept aircraft availability low, and market values high, thereby limiting the conversions of 737-300s/-400s and 757-200s in recent years.

Most freight operators have their aircraft acquired and financed for them by lessors and financial institutions. The market lease rates that they are prepared to pay need to equal a lease rate factor of 1.5% per month of total capital invested

The availability of 737-300s has increased over the past year with the result that values have declined and pushed the aircraft into the zone of convertibility.

by lessors and financiers. This determines the maximum payable for an aircraft to make conversion economically viable.

Monthly market lease rates for older 757-200s with lower MZFWs are $220,000-230,000. Rates are more for higher MZFW aircraft, and Bill Gardner, president of Meridian Aerospace, says the market will bear a monthly lease rate of $240,000, and as much as $300,000.

Rates of $240,000 per month limit the total expense of putting the aircraft into service at $16-18 million.

Monthly market lease rates for the 737-300F are $130,000-150,000, and up to $170,000 for the -400F. This limits the cost of putting the aircraft into operation at $10 million for the 737-300F and $11.5 million for the -400F.

The combined cost of maintenance and freighter conversion for a 737-300 is $4.8-5.2 million, and $5.4-5.7 million for a 737-400. This limits to $5 million the price of a 737-300 and -400 that would allow acquisition and conversion of these aircraft to freighter to be economic.

The additional cost of maintenance for the 757-200F will be $4.5-5.5 million, while conversion to freighter will add a further $3.7 or $4.6 million, depending on programme chosen. The total cost of maintenance and conversion will be $8.2-10 million. This caps the acquisition cost of feedstock aircraft at $8-9 million.

757-200

The availability of 757s has been limited in recent years, and demand could remain high in the passenger sector. Older 757s up to line number 210, built in 1989, will only produce low MZFWs of 184,000lbs. Aircraft higher than line number 210 can have their MZFWs upgraded to 188,000lbs by a Boeing SB, or to 192,000lbs and 194,000lbs by a new Precision Conversions modification.

Any 757s on the market in recent years have been acquired quickly by passenger airlines. Gardner notes that private equity funds have been competing heavily for the 757 and have forced up values. He estimates 1990-1993-built aircraft to cost $12-14 million, and says that it is too expensive to covert anything built after 1990. Jared Dowell, vice president at Compass Capital Corporation, agrees that $9 million is the right level where conversion to freighter can be economically justified. "The current values of $12 million for higher line number aircraft make them 20-30% too expensive for conversion. Also, many aircraft are still on lease, and so will not be available for some time. Northwest and Delta, which are likely to merge, have some of the oldest 757s, and could retire 20-30 in their fleet consolidation. Other airline mergers or even bankruptcies are possible, given high fuel prices and waning passenger demand. This would increase aircraft availability and make convertibility affordable."

737-300/-400

The availability of 737-300s has increased over the past year. "Continental Airlines has announced that it will park 48 737-300s in 2008 and 2009, which is a substantial part of its fleet," says Dowell. "Several other carriers are likely to retire -300s. Aircraft built in the late 1980s now have values of $5-6 million, which is 15-20% lower than six months ago. Values are likely to fall further given the increased availability, and the pressure from high oil prices. There are a lot of aircraft whose leases will end in 2011/12, and so availability will increase. Older 737-300s are therefore already in the zone of convertibility."

Fewer 737-400s are available, but their numbers are likely to increase due to passenger airline fleet renewals and rising fuel prices. "Late 1980s- and early 1990s-built aircraft have fetched $7-8 million in recent years, but these values are now sliding," says Dowell. "There are 92 -400s in operation with US passenger carriers, and it is likely that some will get parked or retired. Aircraft prices will need to fall to $4.5-5.5 million to make conversion economic. Values could reach $2-3 million if major carriers retire large numbers of -400s."

A320/321

The first A320 and A321 conversions are still three to four years away, and it is hard to predict what lease rate the freight market might bear. The A320F has similar payload characteristics to the 737-400F, but the A320 has underfloor containers. At current market conditions the lease rates might be $170,000-180,000 per month. This would limit the total cost of preparing the aircraft for service at $12-14.5 million. The total cost of conversion and maintenance will be $8 million, thereby capping the acquisition cost of the feedstock aircraft at $7 million. "Values of the oldest A320s are $9-10 million, and $13-14 million for early 1990s-built aircraft," says Dowell. Values need to drop to make conversion economic, and are likely to do so by 2011 when the first conversions are available.

The A321 has superior freight capacity to the 727-200F, and is also between the 737-400F and 757-200F. The lease rates for the A321Fs are likely to be $200,000 per month at today's market conditions. This limits total expenditure on preparing an aircraft for service at $13.5-16 million.

This limits the acquisition cost of the aircraft to $5-8 million, which is higher than the current market values of the oldest A321s. The first aircraft are 14 years old, and have a value of $20 million. Values will still be too high when the first conversion is due in 2012. AC