The A330 and A340 are two candidates to replace the ageing medium-widebody freighter fleet. The revenue-generating capacity and relative strengths of two different conversion concepts are examined here.

A330P2F versus the A330 & A340LCF: freight & revenue generating capacity

Despite relatively stagnant demand in the air freight market there will be a need for younger medium-widebody freighters to replace ageing types such as the 767-200F, A300B4, A310 and DC10-10/-30 in the next five years *(see Replacement options DC10, A300B4, A310 & 767-200 freighters, Aircraft Commerce, June/July 2013, page 53).*

There are two potential freight conversion options in development, based on the A330 and A340 platforms.

EADS-EFW and ST Aerospace, together with Airbus, have collaborated to develop a passenger-to-freighter (P2F) conversion programme for Airbus A330-200s and -300s.

At the same time, The Eolia Group has been working on a Low Cost Conversion Freighter (LCF) programme for Boeing and Airbus medium widebody aircraft, including the A330 and A340. The Eolia Group was the instigator of the PSF Conversions 747-400 conversion programme. It established LCF Conversions Ltd in 2011 to develop its medium widebody conversion concept.

The proposed revenue-generating capacities of converted A330P2F, A330LCF and A340LCF aircraft are compared here, together with the relative strengths of each programme.

P2F conversion

The A330P2F programme was officially launched in February 2013. Airbus has provided original equipment manufacturer (OEM) data to ST Aerospace, which will supply the required certification and conversion kits. ST Aerospace is also expected to provide 30% of the conversion capacity once the programme is under way. EADS-EFW is responsible for A330P2F marketing, sales and customer support, and will be the programme lead during the industrialisation phase. It will perform the majority of conversions.

The A330P2F conversion will be available for both -200 and -300 series aircraft. The conversion will involve replacing the existing passenger cabin fittings with a Class E cargo compartment, and installing a 141-inch wide by 101-inch high main deck cargo door. The converted freighter is designed with a powered cargo loading system (PCLS), but a manual cargo loading system (MCLS) is also available.

Although a launch customer is yet to be secured, the first prototype A330P2F will be delivered in 2017. "The first aircraft to be converted will be a -300," explains Thomas Centner, sales aircraft conversion at EADS-EFW. "The prototype -200 is due for delivery in 2018."

As an MRO service provider EADS-EFW offers the opportunity to carry out C Checks in parallel with the conversion

The LCF conversion for the A330 and A340 is a lower cost alternative to a conventional passenger-to-freighter conversion. This is because the LCF modification loads freight through existing lower deck cargo doors, and so dispenses with the need for an expensive and heavy main deck freight door. ULDs and pallets are transferred to the main deck via internal lifts.

The A340-300 has the advantage of having a low market value compared to other A340 variants and the A330. The A340-300LCF could have an on-ramp cost of less than $20 million, less than half the on-ramp cost of a A330-200/-300P2F.

process. "With the level of access required for the conversion it makes sense to combine this with a maintenance check in order to minimise downtime," says Centner.

LCF conversion

Research and design work into the LCF concept began in 2010. The design and certification is managed by ACE Corporation of Seattle.

The LCF programme covers medium widebody aircraft in the A330, A340 and 777 families. This includes the A330-200/-300 and the A340-300/-500/-600.

LCF is currently the only conversion programme that offers a freighter modification for the A340. It does not yet have a launch customer.

The LCF programme offers a cheaper solution to traditional dedicated freighter conversions.

The LCF concept costs less than a traditional conversion because it does not involve the installation of a large cargo door or a reinforced main deck floor. Operators would therefore not be obliged to maintain high utilisation rates to offset acquisition costs.

It is estimated that an LCF conversion will take about six weeks to complete. During the conversion the passenger cabin fittings are replaced with a Class E compartment. This includes the installation of a 9G barrier net and smoke curtain, a smoke detection system and optional window plugs.

Cargo is loaded through the lower deck cargo doors. A pair of internal lifts will be installed near the forward and aft cargo doors so that pallets and unit load devices (ULDs) can be raised to the main deck. These lifts will be level with the lower deck floor when in the lowered position. A lightweight CLS will also be installed on the main deck.

The LCF conversion will cost less and have a shorter conversion turnaround time than traditional P2F modifications, but will have drawbacks in other areas.

The size of ULDs and pallets that can be loaded on the main deck will be restricted by the dimensions of the lower deck cargo doors and lower deck space. This limits the height of ULDs and pallets that can be loaded on the main deck to 64 inches, and subsequently restricts the volume of freight that can be carried.

LCF Conversions points out that about 60% of freight is currently carried in lower holds and configured in lower hold containers tailored to the 64-inch height restriction. It believes that this trend will increase.

Another potential limitation is a weight restriction for upper deck freight owing to the lack of a reinforced floor.

LCF Conversions does not see this as a problem. It points out that 45 tonnes can be accommodated on the main deck of an A330-300 or A340-300 without strengthening the floor. This limit would be higher for larger A340 variants. If heavy loads need to be carried they can be positioned in the lower deck.

"Since 2008 the air freight industry has been in decline," says Andy Coupland, independent consultant to LCF Conversions Ltd. "With the exception of a positive blip in 2010 there has been a fall in both tonnage and yields. Although recent International Air Transport Association (IATA) figures show a year-on-year improvement for November 2013, it is too early to say whether this represents a turnaround.

"The general decline in freight volumes has been coupled with an increase in available belly cargo capacity from aircraft such as the 777-300ER," continues Coupland. "These factors, along with rising conversion costs, have prompted some to question the future for dedicated freight aircraft. Pure freighters are currently judged to be higher risk and lease finance for conversions has dried up.

"There are a number of approaches that could minimise the risk of operating freight aircraft in the current environment," explains Coupland. "The first is to invest in an efficient aircraft with low fuel burn, such as the 777F. This has a good payload-range performance relative to its size but, due to its acquisition cost, will need to fly 4,500-5,000 hours a year to keep unit costs low.

"An alternative would be to source freighters with much lower on-ramp costs," adds Coupland. The on-ramp cost is the sum of aircraft acquisition and conversion costs.

Revenue generating capacity

A key indicator of an aircraft's revenue-generating capacity is the volumetric payload at various packing densities.

The volumetric payload is calculated by multiplying the available cargo volume by the packing density, up to the aircraft's maximum packing density.

The maximum packing density is calculated by dividing the net structural payload by the available cargo volume.

The maximum packing density indicates the optimum density at which freight can be packed while making full use of the aircraft's available volume and structural payload.

The net structural payload is the actual weight of the freight that can be carried. It is calculated by subtracting the tare weight of containers or pallets from the aircraft's gross structural payload.

The type and configuration of ULDs and pallets will influence the maximum packing density. It is generally higher when pallets are used, because they have lower tare weights than ULDs, leading to a higher net structural payload.

A330P2F, A330LCF & A340LCF BASIC SPECIFICATIONS

	A330-200P2F	A330-300P2F LGW	A330-300P2F HGW	A330-200LCF	A330-300LCF LGW	A330-300LCF HGW
Weight Variant	022	004	052	022	004	052
MTOW (lbs)	513,677	460,766	513,677	513,677	460,766	513,677
MLW (lbs)	401,241	401,241	412,264	401,241	401,241	412,264
MZFW (lbs)	374,786	379,195	385,809	374,786	379,195	385,809
OEW (lbs)	244,713	246,918	251,327	235,544	240,216	240,216
Gross structural Payload (lbs)	130,073	132,277	134,482	139,242	138,979	145,593
Range (nm)	4,300	2,400	3,800	4,300	2,400	3,800

	A340-300LCF LGW	A340-300LCF HGW	A340-500LCF	A340-500LCF	A340-600LCF	A340-600LCf
Weight Variant	004	026	001	101	001	101
MTOW (lbs)	573,202	606,271	820,119	837,756	811,301	837,756
MLW (lbs)	414,469	423,287	535,723	542,337	570,997	584,225
MZFW (lbs)	392,423	399,037	507,063	511,472	540,132	553,360
OEW (lbs)	248,344	250.840	334,452	334,452	347,226	347,226
Gross structural Payload (lbs)	144,079	148,197	172,611	177,020	187,393	187,393
Range (nm)	4,650	5,300	7,100	7,500	5,500	6,050

Notes:
1). A330LCF OEWs based on Trent-powered aircraft.
2). A340-600 structural payload restricted to 187,393lbs by shear load limitation.
3). MTOW range for A330-300 WV004 is 460,766lbs - 473,994lbs - There is a linear trade-off relationship between MTOW/MZFW. If MTOW increases MZFW decreases.
4). OEWs may vary by individual aircraft- OEWs for P2F conversions based on target gross payload of 59t for A330-200, 60t for A300-300LGW and 61t for A330-300HGW

Standard packing densities vary depending upon the type of cargo. General freight usually has a packing density of 7.0-12.0lbs per cu ft or higher. These items can be bulky and are often accommodated on pallets.

Express package or integrator operations involve transporting parcels and mail. These are normally accommodated in ULDs with lower packing densities of 6.5-8.5lbs per cu ft. Express package operations tend to generate higher yields than general freight.

The LCF conversion is aimed at both express and general freight operations. The absence of a large main deck cargo door means that the LCF-converted aircraft is not suitable for outsize cargo loads.

There are many potential ULD and pallet configurations for A330 and A340 freighters. The tare weight and volume capacity of ULDs and pallets of similar dimensions can also vary by manufacturer.

To provide a comparison of the potential revenue-generating capacity of the various A330P2F, A330LCF and A340LCF options, two specific freight configurations are considered here.

The first is based on the use of ULDs that offer one of the highest possible containerised volumes *(see table, page 56)*.

The second is based on the use of pallets that offer one the highest possible palletised volumes *(see table, page 58)*. The tare weight and volume assumptions for the various ULDs and pallets are also summarised *(see table, page 59)*.

A330

There are 979 active and parked A330s in a passenger configuration. These are split between the -200 (488) and the larger -300 (491) series aircraft.

Airbus has produced multiple weight variants (WVs) of both the A330-200 and -300. There is a distinct split between low gross weight (LGW) early model A330-300s and later high gross weight (HGW) examples.

LGW A330-300s were manufactured up to 1998 from L/N 012 to 244. The maximum take-off weight (MTOW) available for these aircraft ranged from 405,650lbs to 480,608lbs. There are 69 active and parked, passenger-configured, LGW A330-300s.

HGW A330-300s were produced from L/N 256 onwards. Between L/Ns 256 and 370 the highest maximum take-off weight (MTOW) available was 507,063lbs. From L/N 375 the highest MTOW option increased to 513,677lbs. A MTOW option of 518,086lbs was introduced from L/N 1,276. This can be retrofitted to A330-300s delivered from mid 2004 onwards.

The A330-200 fleet does not have the same disparity in weight specifications. For all A330-200s the highest MTOW available has been 507,063lbs or more.

In this analysis, individual WV specifications have been chosen to illustrate the revenue-generating capacity of A330-200s and A330-300s. The WVs selected offer some of the highest MZFWs, since this will result in freighters with higher payloads. WV022 was chosen to demonstrate the revenue-generating potential of a typical A330-200. WV004 and WV052 were chosen to represent the respective revenue-generating potential of LGW and HGW A330-300s. The basic weight data for these WVs for P2F and LCF converted A330s is summarised *(see table, this page)*.

A330-200P2F

The A330-200P2F would have a gross structural payload of 130,073lbs.

When configured with the ULDs it would offer a total containerised volume of 16,875 cu ft, and a net structural payload of 111,578lbs. The maximum packing density is 6.61lbs per cu ft.

If loaded with pallets, the A330-200P2F could offer a cargo volume of 16,260 cu ft with a tare weight of 8,764lbs. The net structural payload in this configuration would be 121,309lbs and the maximum packing density would be 7.46lbs/cu ft.

OPTIMUM VOLUME ULD FREIGHT CONFIGURATION A330P2F, A330LCF, A340LCF

A/C TYPE	A330-200P2F	A330-300P2F LGW	A330-300P2F HGW	A330-200LCF	A330-300LCF LGW	A330-300LCF HGW
Weight Variant	022	004	052	022	004	052
Gross structural Payload (lbs)	130,073	132,277	134,482	139,242	138,979	145,593
Main deck						
Type of ULD	AMV + AAX + AAX	AMV + AAX	AMV + AAX	LCF AAJ	LCF AAJ	LCF AAJ
Number	18 + 2 + 3	22 + 4	22 + 4	23	25	25
Volume (Cu Ft)	12,155	13,790	13,790	9,361	10,175	10,175
Tare weight (lbs)	13,163	14,870	14,870	12,926	14,050	14,050
Lower deck						
Type of ULD	AMF + LD3	AMF + LD3	AMF + LD3	AMF + LD3	AMF + LD3	AMF + LD3
Number	8 + 2	10 + 2	10 + 2	8 + 2	10 + 2	10 + 2
Volume (cu ft)	4,720	5,824	5,824	4,720	5,824	5,824
Tare weight (lbs	5,332	6,566	6,566	5,332	6,566	6,566
Total Volume (cu ft)	16,875	19,614	19,614	14,081	15,999	15,999
Total tare weight (lbs)	18,495	21,436	21,436	18,258	20,616	20,616
Net structural payload (lbs)	111,578	110,841	113,046	120,984	118,363	124,977
Max packing density (lbs/cu ft)	6.61	5.65	5.76	8.59	7.40	7.81
Volumetric payload @ 6.5lbs/cu ft	109,688	110,841	113,046	91,527	103,994	103,994
Volumetric payload @ 7.0lbs/cu ft	111,578	110,841	113,046	98,567	111,993	111,993
Volumetric payload @ 7.5lbs/cu ft	111,578	110,841	113,046	105,608	118,363	119,993
Volumetric payload @ 8.0lbs/cu ft	111,578	110,841	113,046	112,648	118,363	124,977

A/C TYPE	A340-300LCF LGW	A340-300LCF HGW	A340-500LCF	A340-500LCF	A340-600LCF	A340-600LCF
Weight Variant	004	026	001	101	001	101
Gross structural Payload (lbs)	144,079	148,197	172,611	177,020	187,393	187,393
Main deck						
Type of ULD	LCF AAJ	LCF AAJ	LCF AAJ	LCF AAJ	LCF AAJ	LCF AAJ
Number	25	25	27	27	31	31
Volume (Cu Ft)	10,175	10,175	10,989	10,989	12,617	12,617
Tare weight (lbs)	14,050	14,050	15,174	15,174	17,422	17,422
Lower deck						
Type of ULD	AMF + LD3	AMF + LD3	AMF	AMF	AMF	AMF
Number	10 + 2	10 + 2	10	10	14	14
Volume (cu ft)	5,824	5,824	5,520	5,520	7,728	7,728
Tare weight (lbs)	6,566	6,566	6,170	6,170	8,638	8,638
Total Volume (cu ft)	15,999	15,999	16,509	16,509	20,345	20,345
Total tare weight (lbs)	20,616	20,616	21,344	21,344	26,060	26,060
Net structural payload (lbs)	123,463	127,581	151,267	155,676	161,333	161,333
Max packing density (lbs/cu ft)	7.72	7.97	9.16	9.43	7.93	7.93
Volumetric payload @ 6.5lbs/cu ft	103,994	103,994	107,309	107,309	132,243	132,243
Volumetric payload @ 7.0lbs/cu ft	111,993	111,993	115,563	115,563	142,415	142,415
Volumetric payload @ 7.5lbs/cu ft	119,993	119,993	123,818	123,818	152,588	152,588
Volumetric payload @ 8.0lbs/cu ft	123,463	127,581	132,072	132,072	161,333	161,333

A330-300P2F

The LGW A330-300P2F would offer a gross structural payload of 132,277lbs. The HGW A330-300P2F would have a higher gross structural payload of 134,482lbs.

In the ULD configuration, both LGW and HGW examples would offer the same containerised volume of 19,614 cu ft. The net structural payloads would be 110,841lbs for the LGW aircraft and 113,046lbs for the HGW aircraft *(see table, this page)*.

At a packing density of 6.5lbs/cu ft, the LGW A330-300P2F would provide a 1,000lbs larger volumetric payload than the A330-200P2F.

At higher packing densities, however, the A330-200P2F would offer a larger volumetric payload than the LGW -300P2F.

Meanwhile, the HGW A330-300P2F would offer larger volumetric payloads than the A330-200P2F and LGW A330-300P2F at all packing densities in the ULD configuration. The A330-300P2F would provide a volumetric payload of 113,046lbs/cu ft at packing densities of 5.76lbs/cu ft and upwards.

In the pallet configuration, the LGW and HGW A330-300P2Fs would provide a total volume of 19,351 cu ft with a tare weight of 10,267lbs *(see table, page 58)*.

The net structural payloads would be 122,010lbs for the LGW aircraft, and 124,215lbs for the HGW aircraft.

The LGW and HGW A330-300P2Fs would provide a larger volumetric payload than the A330-200P2F, and the A330LCF variants, in the pallet configuration, regardless of the packing density. This disparity increases at lower packing densities.

A330-200LCF

The A330-200LCF would have a gross structural payload of 139,242lbs. This is about 9,200lbs higher than the A330-200P2F *(see table, page 54)*.

In the ULD configuration, the A330-200LCF would provide a total volume of 14,081 cu ft. This is 2,800 cu ft less than the A330-200P2F.

The difference in volume is due to the height restriction for main deck ULDs and pallets on LCF-converted aircraft.

The A330-200LCF would have a net structural payload of 120,984lbs. Up to packing densities of 7.92lbs/cu ft, the A330-200P2F has a larger volumetric payload than the A330-200LCF in the ULD configuration.

The A330-200LCF has a higher volumetric payload than the -200P2F with higher packing densities.

In the pallet configuration, the A330-200LCF provides a total cargo volume of 13,769 cu ft and has a net structural payload of 129,949lbs.

At packing densities of up to 8.81lbs/cu ft, the A330-200P2F has a larger volumetric payload than the -200LCF in the pallet configuration.

A330-300LCF

The LGW and HGW A330-300LCF offer gross structural payloads of 138,979lbs and 145,593lbs.

In the ULD configuration, the A330-300LCFs offers a containerised volume of 15,999 cu ft *(see table, page 56)*. This is about 3,600cu ft less than the P2F converted A330-300s.

The net structural payloads would be 118,363lbs for the LGW A330-300LCF, and 124,977lbs for the HGW aircraft *(see table, page 56)*.

The LGW A330-300LCF would offer smaller volumetric payloads than the -300P2F version at packing densities of up to 6.92lbs/cu ft. The -300LCF has higher volumetric payloads at higher packing densities.

The HGW A330-300LCF has higher volumetric payloads than its LGW counterpart at packing densities of up to 7.06lbs/cu ft. This situation is reversed at higher packing densities.

If loaded with pallets, the LGW and HGW A330-300LCF could offer a cargo volume of 15,534 cu ft, which is 3,800 cu ft less than P2F converted A330-300s.

The net structural payloads would be 128,713lbs for LGW and 135,327lbs for HGW A330-300LCFs in the pallet configuration. This is 6,700lbs and 11,100lbs higher than the P2F A330-300s.

When using pallets, the A330-300P2F offers superior volumetric payloads to the -300LCF aircraft at lower packing densities.

The disparity in volumetric payload falls as the packing density increases.

At higher packing densities, the LGW A330-300LCF provides a larger volumetric payload than the -300P2F.

The HGW A330-300LCF would exceed the volumetric payload of the HGW A330-300P2Fs at packing densities of 8.0lbs/cu ft and higher.

A340

There are 334 active and parked A340s in a passenger configuration. This includes 195 A340-300s, 29 -500s and 94 -600s.

There are a number of different WV options available for each A340 series.

OPTIMUM VOLUME PALLET FREIGHT CONFIGURATION A330P2F, A330LCF, A340LCF

A/C TYPE	A330-200P2F	A330-300P2F LGW	A330-300P2F HGW	A330-200LCF	A330-300LCF LGW	A330-300LCF HGW
Weight Variant	022	004	052	022	004	052
Gross structural Payload (lbs)	130,073	132,277	134,482	139,242	138,979	145,593
Main deck						
Type of ULD	96” x 125” x 96”	96” x 125” x 96”	96” x 125” x 64”	96” x 125” x 64”	96” x 125” x 64”	96” x 125” x 64”
Number	18 SBS + 4 SR	22 SBS + 4 SR	22 SBS + 4 SR	3 + 20 contoured	3 + 22 contoured	3 + 22 contoured
Volume (Cu Ft)	11,916	14,060	14,060	9,425	10,243	10,243
Tare weight (lbs)	6,072	7,176	7,176	6,601	7,175	7,175
Lower deck						
Type of ULD	96” x 125” + LD3	96” x 125” + 88” x 125”	96” x 125” + 88” x 125”	96” x 125” + LD3	96” x 125” + 88” x 125	96” x 125” + 88” x 125
Number	8 winged + 2	9 winged + 2	9 winged + 2	8 winged + 2	9 winged + 2	9 winged + 2
Volume (cu ft)	4,344	5,291	5,291	4,344	5,291	5,291
Tare weight (lbs	2,692	3,091	3,091	2,692	3,091	3,091
Total Volume (cu ft)	16,260	19,351	19,351	13,769	15,534	15,534
Total tare weight (lbs)	8,764	10,267	10,267	9,293	10,266	10,266
Net structural payload (lbs)	121,309	122,010	124,215	129,949	128,713	135,327
Max packing density (lbs/cu ft)	7.46	6.31	6.42	9.44	8.29	8.71
Volumetric payload @ 6.5lbs/cu ft	105,690	122,010	124,215	89,499	100,971	100,971
Volumetric payload @ 7.0lbs/cu ft	113,820	122,010	124,215	96,383	108,738	108,738
Volumetric payload @ 7.5lbs/cu ft	121,309	122,010	124,215	103,268	116,505	116,505
Volumetric payload @ 8.0lbs/cu ft	121,309	122,010	124,215	110,152	124,272	124,272

A/C TYPE	A340-300LCF LGW	A340-300LCF HGW	A340-500LCF	A340-500LCF	A340-600LCF	A340-600LCF
Weight Variant	004	026	001	101	001	101
Gross structural Payload (lbs)	144,079	148,197	172,611	177,020	187,393	187,393
Main deck						
Type of ULD	96” x 125” x 64”	96” x 125” x 64”	96” x 125” x 64”	96” x 125” x 64”	96” x 125” x 64”	96” x 125” x 64”
Number	3 + 22 contoured	3 + 22 contoured	3 + 24 contoured	3 + 24 contoured	3 + 28 contoured	3 + 28 contoured
Volume (Cu Ft)	10,243	10,243	11,061	11,061	12,697	12,697
Tare weight (lbs)	7,175	7,175	7,749	7,749	8,897	8,897
Lower deck						
Type of ULD	96” x 125” + 88” x 125	96” x 125” + 88” x 125	96” x 125”	96” x 125”	96” x 125”	96” x 125”
Number	9 winged + 2	9 winged + 2	10 winged	10 winged	14 winged	14 winged
Volume (cu ft)	5,291	5,291	5,050	5,050	7,070	7,070
Tare weight (lbs)	3,091	3,091	2,870	2,870	4,018	4,018
Total Volume (cu ft)	15,534	15,534	16,111	16,111	19,767	19,767
Total tare weight (lbs)	10,266	10,266	10,619	10,619	12,915	12,915
Net structural payload (lbs)	133,813	137,931	161,992	166,401	174,478	174,478
Max packing density (lbs/cu ft)	8.61	8.88	10.05	10.33	8.83	8.83
Volumetric payload @ 6.5lbs/cu ft	100,971	100,971	104,722	104,722	128,486	128,486
Volumetric payload @ 7.0lbs/cu ft	108,738	108,738	112,777	112,777	138,369	138,369
Volumetric payload @ 7.5lbs/cu ft	116,505	116,505	120,833	120,833	148,253	148,253
Volumetric payload @ 8.0lbs/cu ft	124,272	124,272	128,888	128,888	158,136	158,136

Early production A340-300s covered WVs 000-004, for which the highest MTOW available was 573,202lbs. For the purposes of this analysis, aircraft within this WV series will be referred to as LGW A340-300s.

All A340-300s in higher WV series will be considered HGW examples. The highest available MTOW for A340-300s increased several times and was 609,578lbs for L/N 544, and from L/N 582 onwards.

The A340-500 fleet has eight WVs across two WV series. The first series of -500s had MTOW options ranging from 811,301lbs to 824,529lbs. This WV series accounts for 25 active and parked, passenger-configured A340-500s from L/Ns 394 to 783.

The second series covers four aircraft between L/Ns 886 and 1,102, and included a MTOW option of 837,756lbs.

Aircraft considered suitable candidates, or ‘feedstock’, for freight conversion are typically 15-20 years old. Only a small number of A340-500s were built, and none of these are yet to reach the typical feedstock age-range, but the availability of used aircraft is high and values are low.

There are five individual WV options split across two WV series for the A340-600. The first WV series includes MTOW options ranging from 804,687 to 811,301lbs. The second WV series includes a 837,756lbs MTOW variant.

There is less feedstock available for the A340-600 than for the A330s or A340-300. The oldest A340-600 airframe is still several years away from the normal feedstock age range.

The removal of A340-500s and -600s from passenger service in favour of more fuel-efficient aircraft could see them become prematurely obsolescent. Their values may reach levels that make them suitable for conversion before they reach traditional feedstock age.

In this analysis WV004 and WV026 have been chosen to demonstrate the respective revenue-generating potential of LGW and HGW A340-300LCFs. For the A340-500LCF and -600LCF WVs 001 and 101 are used. The basic weight data for these WVs for A340LCFs is listed *(see table, page 54)*.

A340-300LCF

An A340-300LCF would be capable of accommodating the same ULD and pallet configurations as an A330-300LCF. This means that the two could provide the same cargo volume and similar volumetric payloads.

The LGW A340-300LCF would have a gross structural payload of 144,079lbs compared to 148,197lbs for a HGW example.

In the ULD configuration the LGW and HGW A340-300LCFs would provide a volume of 15,999 cu ft, the same as the A330-300LCFs and about 3,600 cu ft less than the A330-300P2Fs.

Compared to the A330-200 conversion options, the A340-300LCF would provide about 900 cu ft less volume than the P2F variant and 1,900 cu ft more than an LCF aircraft.

The net structural payloads would be 123,463lbs for the LGW A340-300LCF and 127,581lbs for the HGW aircraft.

At low packing densities, P2F converted A330-200s and -300s would offer a larger volumetric payload than an A340-300LCF.

At packing densities higher than 7.0lbs/cu ft, the A340-300LCF's volumetric payload would be larger than the A330-200P2F's in the ULD configuration. It would offer larger volumetric payloads than the LGW and HGW A330-300P2Fs at packing densities equal to and above 6.93 and 7.07lbs/cu ft respectively.

In the pallet configuration, the LGW and HGW A340-300LCFs would offer a cargo volume of 15,534 cu ft, the same as the A330-300LCFs and about 3,800 cu ft less than the A330-300P2Fs.

The net structural payload for a pallet-loaded LGW A340-300LCF would be 133,813lbs, 11,800lbs higher than that of the LGW A330-300P2F.

The HGW A340-300LCF would have a net structural payload of 137,931lbs, which is 13,700lbs higher than that for the HGW A330-300P2F.

A340-500LCF

The A340-500 has a longer fuselage than the A340-300, which allows the -500 to carry additional ULDs and pallets on the main deck. Its lower deck volume is slightly restricted by an additional belly fuel tank.

The lower weight A340-500LCF would have a gross structural payload of 172,611lbs compared to 177,020lbs for the higher weight example.

In the ULD configuration, an A340-500LCF would provide a total cargo volume of 16,509 cu ft.

The lower weight A340-500's net structural payload would be 151,267lbs. The A340-500LCF's net structural payload of the higher weight would be 155,676lbs.

At a packing density of 6.5lbs/cu ft, an A340-500LCF would provide a volumetric payload of 107,309lbs/cu ft.

In the pallet configuration, an A340-500LCF would provide a total volume of 16,111 cu ft.

The net structural payload for a pallet-loaded A340-500LCF would be 161,992lbs for a low weight example and 166,401lbs for the higher weight aircraft.

The A330-200P2F and -300P2F offer larger volumetric payloads at low packing densities in the pallet configuration.

A340-600LCF

The A340-600 has a longer fuselage than the -300 and -500. The A340-600LCF offers more cargo volume than any of the other LCF and P2F conversion options based on the ULD and pallet configurations used in this analysis *(see tables, pages 56 & 58)*.

The A340-600LCF would be restricted to a gross structural payload of 187,393lbs by shear load limitations. This means the only advantage in selecting the higher-weight example would be its longer range.

The A340-600LCF in a ULD configuration would provide a total volume of 20,345 cu ft.

The A340-600LCF's net structural payload would be 161,133lbs in the ULD configuration.

The A340-600 would provide larger volumetric payloads than any of the alternative P2F or LCF aircraft at any packing density when loaded with ULDs.

In the pallet configuration, the A340-600LCF would provide a volume of 19,767 cu ft.

The net structural payload of the A340-600LCF would be 174,478lbs in the pallet configuration.

When loaded with pallets, the A340-600LCF would offer larger volumetric payloads than the other P2F and LCF options at all packing densities.

Acquisition & conversion

The cost of a P2F conversion for an A330-200 will be about $15.5 million, based on 2016 values. Selecting the PCLS would add $1.4 million, leading to a total conversion cost of about $16.9 million.

The P2F conversion of an A330-300 will cost $16.0 million at 2016 values. The PCLS for the -300 would add $1.5 million for a total conversion cost of $17.5 million.

LCF conversions of A330s and A340s will cost $6.5 million including the CLS.

Avitas's online valuation service offers an indication of current market values for A330s and A340s. These can be combined with the P2F and LCF pricing to indicate the total acquisition and

ULD/PALLET VOLUME & TARE ASSUMPTIONS

ULD/Pallet	Volume (cu ft)	Tare Weight (lbs)
Main deck		
AMV	535	571
AAX	505	577
LCF AAJ	407	562
96" x 125 " x 96" SBS	536	276
96" x 125" x 96" SR	567	276
96" x 125" x 64"	415	287
96" x 125" x 64" contoured	409	287
Lower deck		
LD3	152	198
AMF	552	617
96" x 125" winged	505	287
88" x 125"	373	254

Notes:
1). SBS = Side-by-side/SR = Single row
2). LCF AAJ data is for proposed container - does not currently exist

A330P2F, A330LCF & A340LCF ON-RAMP COSTS

Aircraft Type	Year of manufacture	Engine type	MTOW (lbs)	Market Value ($m)	P2F Cost ($m)	LCF Cost ($m)	P2F on ramp cost ($m)	LCF on-ramp cost ($m)
A330-200	1999	Trent 772B-60	513,677	35.9	16.9	6.5	52.8	42.4
A330-300 (LGW)	1997	Trent 772B-60	467,380	22.2	17.5	6.5	39.7	28.7
A330-300 (HGW)	2001	Trent 772B-60	513,677	43.7	17.5	6.5	61.2	50.2
A340-300 (LGW)	1995	CFM56-5C4	573,202	13.5		6.5		20.0
A340-300 (HGW)	1999	CFM56-5C4	606,271	19.1		6.5		25.6
A340-500	2003	Trent 556A2-61	820,119	35.6		6.5		42.1
A340-600	2003	Trent 556A2-61	811,301	38.5		6.5		45.0

Notes:
1). CMV data from Avitas' online valuation service. Values based on half-life maintenance condition.
2). P2F and LCF conversion costs include provision for CLS.
3). P2F conversion cost is based on 2016 value estimate.
4). MTOW data provided by Avitas is in Tonnes. Converted to lbs by AC

conversion or 'on ramp' costs for the different A330 and A340 freighter options. The conversion, acquisition and on-ramp costs are listed *(see table, this page)*. These only offer a general guide owing to some inconsistencies in the aircraft vintages being compared, and the fact that the P2F conversion cost is based on a 2016 price estimate.

An LCF conversion costs $10.4 million less than the P2F option for an A330-200 and $11 million less than for an A330-300. The on-ramp costs for LCF- and P2F-converted A330s therefore differ by the same margin.

The biggest difference in on-ramp costs is between LCF-converted A340-300s and P2F-converted A330s, due to lower conversion costs and the lower market value of A340-300 airframes. Depending upon the aircraft's vintage and MTOW, the on-ramp cost for a LGW A340-300LCF could be $20 million. This is potentially half the on-ramp cost of a LGW A330-300P2F, and only one-third of that for a HGW A330-300P2F.

There are some indications that A330s and A340s could be traded for prices below these current market values. Gary Fitzgerald, managing director at Stratos, believes an LGW A340-300 with half-life engines could be acquired for $5-10 million. He suggests that a LGW A330-300 with high-life Trent engines could trade for as little as $8 million and a 1999 vintage HGW A330-300 with half-life engines for about $20 million.

This could potentially result in on-ramp costs of $11.5 million for a LGW A340-300LCF, compared to $25.5 million for a LGW A330-300P2F, and $37.5 million for a HGW A330-300P2F.

A340 operations

Despite lower acquisition costs, an important consideration for potential A340LCF operators is fuel burn. With four engines versus the A330's two, the A340 burns more fuel, so it is more expensive to operate. The A340-300 will burn 12-15% more fuel than an A330.

It might also be argued that a four-engined aircraft will have higher maintenance costs than a twin-engined type, with two more engines and more rotable spares and life-limited parts (LLPs) to support. This could be offset by the availability of cheap replacement engines. As A340s are replaced in passenger operations by more economical aircraft, their airframe and engine values will continue to decrease. It might be possible for A340LCF operators to source replacement engines at lower cost than putting existing ones through a shop visit when LLP replacements become due.

Coupland believes that the A340's four engines offer flexibility. "First there is no need for extended range twin-engine operations (ETOPs) approval for A340s." This means an operator can save on flightcrew and maintenance certification costs.

The extra range of the A340LCF aircraft could also provide advantages. "The A340LCF could be used to develop longer-distance freight routes that other medium-widebody freighters may not be able to operate without a re-fuelling stop," says Coupland. "Integrator operations are carried out within certain time constraints. It is not easy to make technical stops within these time constraints so an aircraft that can operate direct opens up new route possibilities.

"Furthermore, a four-engined aircraft will always have superior payload-range performance under hot and high conditions," says Coupland. "For operations from airports in Central and South America, and East and South Africa, this is a decisive advantage."

When carrying full payloads a HGW A340-300LCF would have an additional range of 1,000nm when compared to the A330-200P2F and 1,500nm compared to the A330-300P2F *(see table, page 54)*.

Conclusion

In both a containerised or palletised configuration, the A330-200 and -300P2F would offer more cargo volume than all the A330 and A340LCF options, with the exception of the A340-600LCF.

The A330P2F's volumetric payload was higher than all of the LCF options, except the A340-600LCF, at a packing density of 6.5lbs/cu ft.

If the packing density is increased, the higher net structural payloads of the A330 and A340LCF aircraft would eventually see their volumetric payloads eclipse those of the P2F variants. The packing densities at which this would take place, and the level to which the volumetric payloads would exceed those of the A330P2Fs, depends on the LCF aircraft type, and on whether the aircraft are configured with ULDs or pallets.

Based on current assumptions, the cost of an LCF conversion will be $10-11 million less than the P2F modification. The biggest difference in on-ramp costs would be between an A340-300LCF and A330P2Fs. The on-ramp cost for an A340-300LCF could be less than a third of that for a HGW A330-300P2F.

Where the A340 family is concerned, the -300 variant is the most likely conversion candidate due to its lower acquisition costs and greater feedstock availability.

The main drawback to selecting the A340 platform for conversion is that it burns more fuel than the A330. AC