A number of 737NG passenger-to-freighter conversion programmes have been announced. The conversion providers and the variants they plan to modify are identified here. The payload and range specifications of potential 737NG freighters are compared to existing 737 Classic solutions.

737NG P-to-F conversion programmes

The 737-300 and -400 dominate the small narrowbody freighter market. These aircraft are beginning to suffer from ageing maintenance issues and a decline in suitable conversion feedstock. Some 737 Next Generation (NG) family variants could replace or supplement 737 Classic freighters.

Several new 737NG passenger-to-freighter (P-to-F) conversions have been announced.

The potential conversion options, payload specifications, and market demand for 737NG freighters, are addressed here.

737 NG Family

The 737NG family first entered service in 1998. More than 4,900 737NG family aircraft are in passenger service.

The 737NG includes four variants, the -600, -700, -800 and -900.

The 737-600 is the smallest member of the family. It has a fuselage length of 97 feet and nine inches, the same as the -500 and -200 series. It is unlikely that any -600s will be converted to freighters.

The 737-700 has the same fuselage as the -300. Both have a fuselage length of 105 feet and seven inches, so the -700 freighter would have the same or similar freight capacity to the -300 freighter. There are several variants of the -700 series including standard, combi and extended range (ER) models.

There are 1,032 737-700s in passenger service. There is only one active -700 combi and two active -700ERs. The passenger variant is therefore the most likely conversion candidate.

The 737-800 has a fuselage length of 124 feet and nine inches. It is 19 feet longer than the -700, and about nine feet longer than the 737-400. The 737-800 freighter would therefore have more freight capacity than the 737-400.

There are 3,486 737-800s in active passenger service.

The largest member of the 737NG family is the -900 series. Its fuselage is eight and a half feet longer than that of the -800, so a 737-900 freighter will have more capacity than the -800.

There are two variants within the 737-900 series: the standard -900 and the -900ER. The -900ER superseded the standard model in 2007 and has proven more successful. There are 299 737-900ERs in active passenger service, compared to just 52 -900s.

P-to-F conversion options

P-to-F conversion programmes have been announced for 737-700s and -800s. There have been no firm announcements regarding 737-900 conversions. If a 737-900 P-to-F conversion programme was launched, standard -900 variants would be the most likely initial feedstock candidates because they are older than the -900ER fleet.

Four organisations have officially launched 737NG P-to-F programmes, or announced their intentions to develop them: Aeronautical Engineers Inc (AEI), IAI Bedek, Boeing and PEMCO.

AEI

AEI announced plans for a 737-800 P-to-F conversion programme in late March 2014. It was the first organisation to officially launch a 737NG conversion programme. "We are currently working to secure the first customers," explains Robert Convey, senior vice president sales & marketing at AEI.

Aircraft converted by AEI will be designated 737-800SFs.

737-800s can have a maximum take-off weight (MTOW) of up to 174,200lbs. A 737-800SF would have a maximum structural payload of about 52,000lbs *(see table, page 82)*.

A 737-800SF will accommodate up to 11 88-inch X 125-inch unit load devices (ULDs) or pallets, plus a further reduced size ULD or pallet. This is one fewer than the 727-200F.

Some of the most likely ULDs to be used in converted 737NG freighters have been summarised *(see table, page 76)*.

In a containerised configuration, a 737-800SF will hold up to 11 AAY ULDs on its main deck, and an extra AEP or LD-3 container on the main deck.

AEI believes it will be issued with a supplemental type certificate (STC) for 737-800 P-to-F conversions by late 2017, and that its conversion will enter production by 2018.

AEI estimates that its 737-800 P-to-F conversion will cost $3.5 million based on January 2017 values. AEI will also offer a passenger-to-combi option.

In both cases, AEI will use licensed Boeing engineering data to develop its conversions after coming to an agreement with Boeing in late 2014. The agreement also includes access to engineering data for the 737-900 non-ER series.

"We will start by converting 737-800s, but also plan to convert -900 series aircraft in the future," explains Convey. "Initial -900 conversions would be for non-ER aircraft," adds Convey.

AEI is not considering P-to-F conversions for 737-600s or -700s, since it considers them too small to compete with the greater volume and payload offered by the 737-800SF.

AEI already offers P-to-F conversions for other narrowbody types. It is the only organisation providing conversions for the MD-80 family. It also has P-to-F programmes for 737-300s and -400s. It recently announced that it has delivered its 50th converted 737-400 freighter.

IAI BEDEK

IAI Bedek has launched P-to-F conversion programmes for the 737-700 and -800. Converted aircraft will be

737 ULD SPECIFICATION ASSUMPTIONS

Container	Volume (cu ft)	Tare weight (lbs)
88" x 125" x 82" (AAY)	438	507
88" x 53" x 63.5" " (AEP)	152	284
80" x 43" x 57" (AYK)	103	220
88" x 78.9" x 62.5" (AYF)	193	270
88" x 125" x 79"	390	450
60.4" x 61.5" x 64" (LD3)	159	168
88" x 125" x 64" (AAK/LD7)	340	463

Notes: ULD specifications will vary by manufacturer

designated 737-700BDSFs and 737-800BDSFs respectively.

A 737-700BDSF would have an MTOW of up to 154,500lbs and a maximum structural payload of about 45,500lbs *(see table, page 82)*.

A 737-700BDSF will be able to hold up to eight 88-inch X 125-inch ULDs or pallets, plus a further two smaller ULDs.

In a containerised configuration, a 737-700BDSF will accommodate up to eight AAY ULDs, plus single AYK and AYF containers.

A 737-800BDSF will have a maximum structural payload of about 54,800lbs *(see table, page 82)*.

A 737-800BDSF will hold up to 11 88-inch X 125-inch ULDs or pallets, plus a further reduced size ULD or pallet.

In a containerised configuration, a 737-800SF will accommodate up to 11 AAY ULDs, plus an additional LD-3 container, on the main deck.

IAI Bedek will bring its 737-700BDSF conversion to market first, followed in the near future by the -800BDSF. The first -700BDSF will be available in 2016. The first customer is expected to be Alaska Airlines.

IAI Bedek has no plans to offer P-to-F conversions for 737-600s or -900s. It already has established conversion programmes for 737-300s and -400s.

Boeing

Boeing achieved authority to offer a 737-800 P-to-F conversion in 2014. It hopes to officially launch the programme in 2015. Converted aircraft would be designated 737-800BCFs.

The maximum structural payload of a 737-800BCF could be up to 57,980lbs, although the typical value will be about 50,300lbs *(see table, page 82)*. The actual value will depend on the operating empty weight (OEW) of the feedstock. The higher payload could be achieved with certain low weight feedstock aircraft.

A 737-800BCF could accommodate the same main deck ULDs as the 737-800BDSF and -800SF. It will hold up to 11 88-inch X 125-inch ULDs or pallets, plus a further reduced-size ULD or pallet.

In a containerised configuration a 737-800BCF could accommodate up to 11 AAY ULDs, plus an additional LD3 container, on the main deck.

The 737-800BCF modification will be based on a service bulletin (SB) rather than an STC. The list price for a 737-800BCF P-to-F conversion was $5 million in 2014. Boeing aims to complete the first conversion in 2017 and enter full production in 2018, provided the programme launches in 2015 as planned.

Boeing does not intend to offer P-to-F conversions for 737-600s or -700s. "There are some technical challenges with converting 737-700s, which makes this uneconomic from Boeing's perspective," explains Dan Da Silva, vice president, modification and conversion services at Boeing Commercial Airplanes.

Da Silva adds that the 737-900 series is an appealing conversion candidate, and that Boeing plans to explore potential -900 conversions in the future.

PEMCO

PEMCO has also announced its intention to pursue 737NG cargo conversions. It is currently developing P-to-F conversions for 737-700s and -800s, and quick change (QC) and combi conversions.

It will initially focus on the 737-700, since they can be obtained on the used market at a lower cost than the -800. "The market will dictate which aircraft will be converted based on acquisition and operational cost," says Pastor Lopez, chief executive officer at PEMCO.

PEMCO expects its 737-700 P-to-F conversion to be available in late 2016.

There are no payload specifications available for PEMCO's proposed 737-700 and -800 converted freighters.

PEMCO already has experience of converting 737 Classics. It offers full P-to-F conversions for 737-300s and -400s, QC and combi conversions for the -300, and combi conversions for the -400.

Market for 737NG freighters

737NG freighters might be used for mail, express package or general freight services. They are likely to have relatively low utilisation.

Types of freight

Express package or integrator operations are normally based on hub-and-spoke networks, with small packages being carried in main deck ULDs at relatively low packing densities. A typical packing density would be 6.5lbs per cubic foot (lbs/cu ft). This can result in an aircraft reaching its volumetric capacity before using its full net structural payload. This is known as 'cubing' or 'bulking' out.

The standard ULDs used by integrators were designed around the fuselage contours of first-generation jet freighters including the DC-8, 707 and 727. These have a base width of 125-inches and a depth or length of 88-inches. They have a contoured profile and can be up to 82-inches in height, depending on the aircraft platform. They are often referred to as AAY ULDs.

737 Classic freighters have been used as feeder aircraft for integrator networks because they have the same fuselage profile as the 707 and 727, and can therefore accommodate AAY ULDs. 737NGs may appeal to integrators for the same reason.

In some cases 737 Classic freighters are operated by third-party airlines on behalf of large integrators, although TNT Airways has built its own fleet of 737-400 freighters.

General freight services are normally point-to-point. General freight items can be larger and bulkier than express packages, and are more likely to be shipped on pallets than ULDs. General freight has higher packing densities than express package cargo. A typical range might be 7.0-9.0lbs per cu ft. The higher packing densities associated with general freight mean that an aircraft can reach its net structural payload limit before utilising all of the available volume. This is known as 'grossing' out.

Position in market

The active narrowbody freighter fleet includes: 248 757-200s; 136 737-300s, of which 32 are QC aircraft; 65 737-400s, 62 727-200s; 23 DC-9s; 17 737-200s;, five 727-100s; and five MD-80s. There are also a small number of DC-8s.

The growth and replacement of the narrowbody freighter fleet completely relies on P-to-F conversions, since there are no new-build aircraft available in this market segment.

There are currently P-to-F conversion

ULD/CONTAINER MAIN DECK CAPACITY OF NARROWBODY FREIGHTERS

Aircraft Type	Max structural payload	Container/Pallet positions
MD-82/-88SF	46,600	12 x (88” x 108”)
MD-83SF	45,100	12 X (88” x 108”)
737-300	42,900-43,100	Up to 8 (88” x 125”) plus one or two reduced-size or up to 9 x (88” x 125”) with final position restricted to height of 64”
737-700BDSF	45,500	8 x (88” x 125”) plus two reduced-size
727-100	43,000	9 x (88” x 125”)
SGW 737-400	43,100-44,000	Up to 10 x (88” x 125”) plus one reduced-size
HGW 737-400	46,100-48,000	Up to 10 x (88” x 125”) plus one reduced-size
737-800	50,300-57,980	11 x (88” x 125”) plus one reduced-size
727-200	59,000	12 x (88” x 125”)
757-200PCF	Up to 84,000	15 x (88” x 125”)

Notes:
1). 757-200 specs based on aircraft converted by Precision Aircraft Solutions with no winglets and RB211 engines.
2). 737 Classic conversions are provided by AEI, IAI and PEMCO. Exact specs depend upon conversion provider.

programmes for the MD-80, 737-300, 737-400, and 757-200.

A converted 737-700BDSF freighter will offer similar gross structural payloads and main deck cargo configurations to 737-300 and 727-100 freighters *(see table, this page)*.

A 727-100 can accommodate up to nine 88-inch X 125-inch ULDs or pallets. A 737-300 freighter can hold up to eight full height 88-inch X 125-inch pallets or containers, plus one or two reduced-size ULDs and pallets, depending on the conversion provider.

AEI also offers a nine-position 737-300SF freighter. It can hold up to nine 88-inch x 125-inch ULDs or pallets, with the last position restricted to 64-inches in height.

IAI Bedek's 737-700BDSF will also accommodate eight full-height 88-inch X 125-inch ULDs or pallets, plus an additional two reduced-size containers.

A 737-700BDSF would have a similar gross structural payload to an MD-80 freighter *(see table, this page)*. Some general freight operators may consider MD-80s to be realistic alternatives to 737NG freighters, owing to their lower acquisition costs. MD-80s are less likely to be considered for express package operations, however, since they have a smaller fuselage cross section than 737s. The MD-80 therefore cannot accommodate the standard height 88-inch X 125-inch ULDs preferred by integrators.

A converted 737-800 freighter would provide a higher gross structural payload and more main deck cargo volume than an MD-80, 727-100, and 737-300, -400 or -700 freighter *(see table, this page)*. The 737-800's longer fuselage means it could hold one more 88-inch ULD or pallet than a 737-400.

A 737-800 freighter would offer slightly less volume than a 727-200F. The fuselage of the 727-200 is eleven-and-a-half feet longer than the 737-800's. This means it can hold up to 12 88-inch X 125-inch ULDs or pallets. The 737-800 can only hold 11 of the same ULDs, plus an additional smaller container or pallet.

A 737-800 freighter would hold four fewer 88-inch X 125-inch ULDs or pallets than a 757-200 *(see table, this page xx)*.

Some of the most obvious demand for converted 737-700s and -800s could come from requirements to replace 737-300 and -400 freighters.

"It would be easy to see the 737-800BCF as a direct replacement for -400 freighters," says Da Silva. "The -800BCF will offer higher payloads and lower operating economics than 737-400 freighters. It could open up new business for 737 Classic freighter operators."

Convey sees the 737-800 as primarily replacing 737-300 and -400 freighters, initially on integrator operations. "The amount of suitable 737-400 feedstock is declining and operators are beginning to look at the -800 as an alternative," says Convey.

Da Silva also highlights how 737 Classic feedstock will decline over the next few years. "By 2017 there will only be 59 737-400s remaining in the typical 15-20 year old conversion age range."

Demand for 737NG freighters could be particularly strong in certain developing economies. "Some countries have imposed regulations limiting the age of aircraft that they will register," says Jacob Netz, senior analyst at the Air Cargo Management Group, expressing his own opinion. "China has set this age limit at 15 years for freighters. Converting younger 737NGs could be one solution to this."

There are more active 737 Classic freighters in China than any other country. Chinese operators looking to replace their aircraft with younger 737-300s or -400s may be restricted by ageing feedstock and their country's aircraft age regulations. 737NG freighters may become a prime alternative in the future.

"Replacing the 737 Classic fleet in China will be one of the main market opportunities for 737NG freighters," says Jack Gaber, senior vice president marketing and business development at IAI Bedek. Gaber also believes that there will opportunities for 737NG freighters in other developing markets.

According to Netz there could be demand for 737NG freighters from start-up carriers, providing they can afford the acquisition or lease costs.

It is also possible that they will appeal to airlines with smaller freighters that are looking to grow their capacity.

Convey believes that the 737-800SF could provide right-sizing opportunities, highlighting the capability gap in Fedex operations between ATR turboprops and 757 freighters.

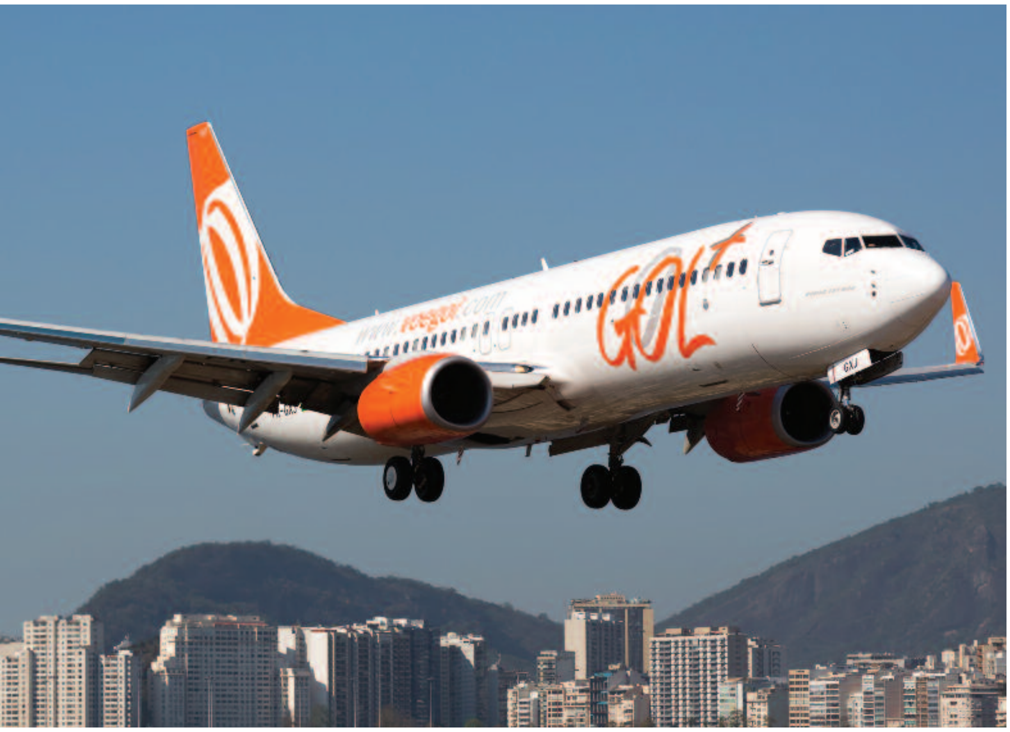
Da Silva believes the 737-800BCF could be a contender for replacing larger freighters. "The 737-800BCF has better economics than the low payload end of the 757 market, where an operator may not have the payload to fill the entire capacity of that airplane."

Some believe that 737NG freighters will appeal to a broad range of operators. "We believe that converted 737NGs will be equally attractive to integrators and general freight operators," says Lopez.

Others do not believe that the large integrators will take 737NG freighters in significant numbers in the near future.

"The 757 is very popular with the large integrators and we believe their focus will be on 757s and 767s for the immediate future," says Gaber. "We do not expect them to go for 737NG freighters in large numbers."

Netz agrees. "The three main express package operators are FedEx, UPS and DHL," he says. "They each have a large fleet of 757s which they will continue to



Several P-to-F conversion programmes have been announced for 737NGs. There are initial plans to convert the -700 and -800 variants. A 737-800 freighter would accommodate one more standard ULD than a 737-400 freighter, but one less than a 727-200 and four less than a 757-200.

operate for the next 15-20 years. DHL recently began replacing some of its older aircraft with younger converted 757s," continues Netz. "It is unlikely that the leading express airlines will buy or lease a significant number of 737NG freighters. Some third-party airlines may take 737NG freighters, however, and sub-contract them to the integrators."

737NG payload & range

Preliminary specifications are available for the 737-700BDSF, 737-800BDSF, 737-800SF and 737-800BCF. *Aircraft Commerce* has analysed the potential net structural payloads of these aircraft, and their volumetric capacities at different packing densities.

The potential payload characteristics of these 737NG freighters are compared with 737-300 and -400 freighters, since these are the aircraft they are most likely to complement and replace.

The 737 Classic specifications used in this analysis are based on IAI Bedek's and AEI's conversions *(see table, page 82)*.

There are two main weight options for the 737-400s, since there are standard gross weight (SGW) and high gross weight (HGW) examples of this variant. AEI also offers two different 737-300SF options. One has nine main deck loading positions and the other has 10.

Assumptions

It was necessary to make a number of assumptions when producing this payload comparison. The results of the analysis should only be considered within the context of these assumptions.

It was decided to compare the payload characteristics of the aircraft in a containerised, rather than a palletised, main deck loading configuration. Multiple ULD configurations are possible for each 737 freighter covered in the analysis. Only one configuration is used here. The specific configurations chosen should provide some of the highest possible cargo volumes.

The internal volumes and tare weights used for each ULD have been summarised *(see table, page 76)*. These are based on real examples, although ULD volume and tare weight vary by manufacturer, as does the precise contour of similar-sized ULDs. The ULDs used for this analysis should provide an accurate idea of likely total volumes and tare weights on a loaded aircraft. It cannot be guaranteed, however, that containers matching these exact specifications will be compatible with all 737 freighters.

The maximum structural payload used for the 737-800BCF is the typical, rather than the highest potential, value. A 737-800BCF with the maximum possible structural payload will therefore be capable of higher volumetric payloads than those shown in this analysis.

Each aircraft's net structural payload has been calculated from its maximum structural payloads. In some cases an aircraft's maximum structural payload exceeds the payload limit for the main deck. This analysis assumes that any payload exceeding main deck limits could be accommodated as bulk freight in the lower hold.

The OEWs used in the analysis are a general estimation. In reality, OEW will vary by individual aircraft.

The OEWs used for the 737-300 and -400 conversions assume the aircraft are not fitted with winglets.

The OEWs used for the 737-700 and -800 conversions are based on aircraft with winglets. About 88% of the active 737-700 fleet and 95% of the -800 fleet is equipped with winglets.

Winglets increase an aircraft's OEW, but reduce fuel burn and increase range. In reality, their weight will only have a minor impact on payload. An aircraft without winglets might have a slightly higher net structural payload, but may also have inferior range and fuel burn.

Payload analysis

One significant measure of an aircraft's freight carrying capacity is its net structural payload. This is the actual weight of the cargo that can be carried once the tare weight of ULDs has been accounted for. The net structural payload is calculated by deducting the tare weight of ULDs or pallets from the aircraft's maximum structural payload.

The three 737-800 freighters would offer the highest net structural payloads of any of the 737 variants considered in this analysis. They would have respective net structural payloads ranging from 44,555lbs to 49,055lbs *(see table, page 82)*. The difference is due to variations in the marketed OEW. Since OEW can only be estimated and will vary by aircraft type, the -800BDSF, -800SF and -800BCF may offer similar average payloads.

The 737-700BDSF would have a net structural payload of 40,954lbs. This is higher than any of the 737-300 or SGW 737-400 freighters which have net structural payloads ranging from 37,862 to 38,987lbs. The 737-700BDSF's net structural payload is similar to that of the HGW 737-400SF, but about 2,000lbs less than that of the HGW 737-400BDSF.

The 737-700BDSF would offer the highest maximum packing density of any of the 737s in this analysis. An aircraft's maximum packing density is calculated by dividing net structural payload by available volume. It is the maximum density at which cargo can be loaded to make optimum use of both the available volume and the net structural payload.

The 737-700BDSF would have a maximum packing density of 8.60lbs/cu ft *(see table, page 82)*. The next highest packing densities are offered by the 737-300BDSF and the 10-position -300SF at 8.22 and 8.02 lbs/cu ft. The 737-800BDSF and -800SF would have maximum packing densities of 7.51 and 7.08 lbs/cu ft. These are the same as each of the conversion providers' HGW-737-400 products.

The 737-800BCF would have a maximum packing density of 6.82lbs/cu ft, similar to the SGW 737-400BDSF. The SGW 737-400SF has the lowest maximum packing density of 6.53lbs/cu ft.

The net structural payloads and maximum packing densities for each 737 variant would have been higher if the analysis had been based on a palletised configuration, rather than the use of ULDs. Pallets offer similar volume but have lower tare weights than ULDs.

A containerised configuration therefore provides a conservative estimate of the aircraft's payload potential.

The volumetric payloads of the different 737 freighter variants have been compared at different packing densities.

6.5lbs per cu ft

All of the 737 freighters cube out at a typical express freight packing density of 6.5lbs/cu ft.

The three 737-800s provide the highest volumetric payload of 42,458lbs at this packing density *(see table, page 82)*. The 737-800BCF uses 95% of its net structural payload, while the -800SF and -800BDSF use 92% and 87%.

The SGW and HGW 737-400s provide the next highest volumetric payloads, ranging from 37,083-37,668lbs. The 737-800 freighters therefore offer nearly 5,000lbs more payload than the 737-400s.

The 737-700BDSF only uses 76% of its available structural payload before cubing out, and offers a volumetric payload of 30,966lbs at this packing density. This is similar to the 737-300 freighters. The 737-300BDSF provides the lowest payload at 30,752lbs.

7.5lbs per cu ft

A packing density of 7.5lbs/cu ft would be relatively high for express freight, and at the lower end of the scale for general freight.

At this packing density the 737-800SF, -800BCF, SGW -400BDSF, SGW -400SF and HGW -400SF gross out. The remaining aircraft all cube out.

The three 737-800s again offer the highest payloads. At this packing density their volumetric payloads range from 44,555-48,990lbs *(see table, page 82)*. The next highest payloads are offered by the HGW 737-400s with a range of 40,862-42,788lbs. The potential payload advantage of a 737-800 freighter compared to a HGW 737-400 could therefore be as high as 8,128lbs or as low as 1,767lbs, depending on the conversion provider and individual aircraft weights.

The 737-700BDSF offers a volumetric payload of 35,730lbs at this packing density, similar to the 737-300 freighter options. The 737-700BDSF has the lowest payload, with the exception of the 737-300BDSF. It uses 87% of its available structural payload before cubing out.

8.5lbs per cu ft

A packing density of 8.5lbs/cu ft would be more common for general freight than express packages.

All the aircraft gross out at this packing density, with the exception of the 737-700BDSF.

The three 737-800s provide the highest volumetric payloads, ranging from 44,555-49,055lbs *(see table, page 82)*. The HGW 737-400s provide the next highest payloads, ranging from 40,862-42,987lbs. The potential payload advantage of a 737-800 freighter compared to a HGW 737-400 could therefore range from 1,568 to 8,193lbs.

At this packing density, the 737-

PAYLOAD CHARACTERISTICS 737 CLASSIC & 737NG FREIGHTERS

Aircraft Type	737-300BDSF	737-400BDSF SGW	737-400BDSF HGW
MTOW (lbs)	Up to 139,500	Up to 143,500	Up to 150,000
MZFW (lbs)	Up to 109,600	Up to 113,000	Up to 117,000
OEW (lbs)	66,500	69,000	69,000
Max structural payload (lbs)	43,100	44,000	48,000
ULDs	8 x AAY + 1 LD3	9 x AAY + 1 88/125/79	9 x AAY + 1 88/125/79
Main deck freight volume (cu ft)	3,663	4,332	4,332
Tare Weight (lbs)	4,224	5,013	5,013
Lower deck volume (cu ft)	1,068	1,373	1,373
Total volume (cu ft)	4,731	5,705	5,705
Total tare weight (lbs)	4,224	5,013	5,013
Net structural payload (lbs)	38,876	38,987	42,987
Max packing density (lbs/cu ft)	8.22	6.83	7.53
Volumetric payload @ 6.5lbs/cu ft	30,752	37,083	37,083
Volumetric payload @ 7.5lbs/cu ft	35,483	38,987	42,788
Volumetric payload @ 8.5lbs/cu ft	38,876	38,987	42,987

Aircraft Type	737-300SF 9 Position	737-300SF 10 Position	737-400SF SGW	737-400SF HGW
MTOW (lbs)	Up to 139,500	Up to 139,500	Up to 143,500	Up to 150,000
MZFW (lbs)	Up to 109,600	Up to 109,600	Up to 113,000	Up to 117,000
OEW (lbs)	66.700	66,700	69,900	70,900
Gross structural payload (lbs)	42,900	42,900	43,100	46,100
ULDs	8 x AAY + 1 AAK	8 x AAY + 1 AEP + 1 LD3	10 x AAY + 1LD3	10 x AAY + 1LD3
Main deck freight volume (cu ft)	3,844	3,815	4,539	4,539
Tare Weight (lbs)	4,519	4,508	5,238	5,238
Lower deck volume (cu ft)	973	973	1,256	1,256
Total volume (cu ft)	4,817	4,788	5,795	5,795
Total tare weight (lbs)	4,519	4,508	5,238	5,238
Net structural payload (lbs)	38,381	38,392	37,862	40,862
Max packing density (lbs/cu ft)	7.97	8.02	6.53	7.05
Volumetric payload @ 6.5lbs/cu ft	31,311	31,122	37,668	37,668
Volumetric payload @ 7.5lbs/cu ft	36,128	35,910	37,862	40,862
Volumetric payload @ 8.5lbs/cu ft	38,381	38,392	37,862	40,862

Aircraft Type	737-700BDSF	737-800BDSF	737-800SF	737-800BCF
MTOW (lbs)	Up to 154,500	Up to 174,200	Up to 174,200	Up to 174,200
MZFW (lbs)	Up to 121,000	Up to 138,300	Up to 138,300	Up to 138,300
OEW (lbs)	75,500	83,500	86,300	88,000
Max structural payload (lbs)	45,500	54,800	52,000	50,300
ULDs	8 x AAY + 1 AYK + 1AYF	11 x AAY +1 LD3	11 x AAY + 1 LD3	11 x AAY + 1 LD3
Main deck freight volume (cu ft)	3,800	4,977	4,977	4,977
Tare Weight (lbs)	4,546	5,745	5,745	5,745
Lower deck volume (cu ft)	964	1,555	1,555	1,555
Total volume (cu ft)	4,764	6,532	6,532	6,532
Total tare weight (lbs)	4,546	5,745	5,745	5,745
Net structural payload (lbs)	40,954	49,055	46,255	44,555
Max packing density (lbs/cu ft)	8.60	7.51	7.08	6.82
Volumetric payload @ 6.5lbs/cu ft	30,966	42,458	42,458	42,458
Volumetric payload @ 7.5lbs/cu ft	35,730	48,990	46,255	44,555
Volumetric payload @ 8.5lbs/cu ft	40,494	49,055	46,255	44,555

Notes:
1). Stated OEWs are estimates. Actual OEW will vary by individual aircraft.
2). Stated max structural payload of 737-800BCF is typical value. Max payload of 57,980lbs is possible.
3). 737-700BDSF has main deck payload limit of 45,000lbs
4). 737-800BDSF and -800SF have main deck payload limit of 52,000lbs.

ESTIMATED ACQUISITION COSTS FOR 737 CLASSICS AND 737NGS

Aircraft Type	MTOW (lbs)	Current Value (US$-millions) 15-year-old	Current Value (US$-millions) 20-year-old	2017 value est (US$-millions) 15-year-old	2017 value est (US$-millions) 20-year-old
737-300	139,500	n/a	2.25	n/a	1.69
LGW 737-400	143,500	4.56	3.5	n/a	2.58
HGW 737-400	150,000	4.64	3.5	n/a	2.58
737-700	154,500	10.5	n/a	10.84	7.81
737-800	174,200	17.05	n/a	15.98	12.48
737-900	174,200	n/a	n/a	11.35	n/a

Source: Oriel

Oriel current market values and lease rates and future base values, assuming 1.5% inflation. All values are for aircraft in half-life maintenance condition

700BDSF has a volumetric payload of 40,494lbs. This is higher than all of the 737-300s and SGW 737-400s. It is only 370lbs less than the HGW 737-400SF.

The 737-300 freighters have the lowest volumetric payloads at this packing density, ranging from 38,381lbs to 38,876lbs.

Payload-range

Converted 737-700s or -800s will have a range advantage over 737 Classic freighters when operating with a maximum payload. Boeing estimates that typical 737-300 and -400 freighters have a range of up to 1,650nm and 1,750nm, with a maximum payload. In comparison, a 737-700BDSF will have a range of 2,200nm. A 737-800 freighter will have a range of up to 2,000nm with its maximum structural payload.

The 737-700BDSF has a range advantage of 550nm over a 737-300 freighter, and its maximum structural payload is 2,400-2,600lbs higher. The 737-700BDSF also has a range advantage of 450nm over a HGW 737-400, but its maximum structural payload is 600-2,500lbs less.

Boeing believes the 737-800 offers the best combination of payload and range capabilities when compared to 737 Classic freighters and the 737-700.

A 737-800 freighter would have a range advantage of at least 350nm over a 737-300. If the highest payload specification for the 737-800BCF is also taken into account, an -800 freighter's maximum structural payload could be 7,200-15,080lbs higher than a 737-300's.

A 737-800 freighter will have a range advantage of at least 250nm, and a maximum structural payload advantage of 2,300-11,880lbs compared to a HGW 737-400.

Aircraft financing

737NGs will have higher acquisition or lease costs than 737 Classics.

The typical P-to-F conversion age range for aircraft is 15-20 years.

The current value of a 15-year-old passenger-configured 737-800 in a half-life maintenance condition, with half-life engines, is $17.05 million *(see table, this page)*, compared to $10.5 million for a 737-700 and $4.64 million for an HGW 737-400.

Some of the first 737NG P-to-F conversions may have taken place by 2017. There will be no 15-year-old 737 Classics remaining by then. At the older end of the feedstock age scale, the estimated 2017 value of a 20-year-old passenger-configured 737-800 in half-life condition is $12.48 million, compared to $7.81 million for a 737-700, $2.58 million for a 737-400 and $1.69 million for a 737-300.

AEI and Boeing estimate that their 737-800 conversion programmes will reach full production in 2018. It is possible that acquisition values for 737-800s may have dropped to lower levels by that time.

"Even with low utilisation and higher acquisition costs, the 737-800BCF will have lower operating costs per-tonne-mile than a 737-400 freighter," claims Da Silva. This is based on the expected acquisition cost of a 737-800 passenger aircraft in 2018 when Boeing's conversion is expected to enter full production, and on the escalated price of the conversion, and airframe and engine maintenance.

A320 competition

In the long term the main competition for 737NG freighters will come from the A320 family. In association with Aeroturbine and GAMECO, PACAVI group is developing a P-to-F conversion for A320 and A321s. Conversions could be available from 2017.

A converted A320 will accommodate 10 88-inch X 125-inch containers, plus an additional smaller container, so it will have more volume than a 737-700 freighter, but slightly less than a 737-800.

A converted A321 will hold up to 13 88-inch X 125-inch ULDs, plus an extra smaller container. It will therefore have more main deck cargo volume than a 737-800 freighter. It is unclear how a converted 737-900 would compare to the A321, since no specifications are available for 737-900 freighters.

Summary

P-to-F conversion programmes have been launched, or are in development for 737-700s and -800s. These are likely to enter full production over the next three years.

Some conversion providers have indicated they may convert 737-900s in the future.

737NG freighters are most likely to replace ageing 737 Classic freighters, although there may also be potential to replace larger aircraft such as the 757.

737-800 freighters will offer higher maximum structural payloads and more cargo volume than 737 Classic and -700 freighters. 737-800 freighters will offer higher net structural payloads and volumetric capacities in a containerised configuration than 737 Classic and 737-700 freighters at the packing densities examined in this analysis.

The 737-700BDSF is similar in size to a 737-300 freighter, so it will offer a similar cargo volume, although its maximum structural payload is slightly higher.

The 737-700BDSF offers similar volumetric payloads to 737-300 freighters at typical express package packing densities. The 737-700BDSF can provide higher volumetric capacities than 737-300 freighters and some 737-400 variants at higher packing densities.

Despite their higher acquisition costs, it has been claimed that 737-800s will be able to demonstrate lower operating costs per tonne-mile than 737-400 freighters by the time P-to-F conversions enter production in 2018.

The A320 family is likely to provide the main competition for 737NGs in the future narrowbody conversion market. AC