737-200 modification & upgrade programmes

Although the youngest 737-200s are 17 years old and the type is declining in popularity, there are several economic modification programmes that can extend the life of good quality aircraft.

There are many major modification and upgrade programmes for the 737-200, which include: Stage 3 noise modifications; performance enhancement kits; auxiliary fuel tank installations; weight upgrades; passenger-to-freighter modifications; and avionic installations.

Stage 3 hushkits

The market for Stage 3 hushkit modification of 737-200s has virtually disappeared, but about 450 of them were modified from 1992 to the late 1990s. Just over 100 aircraft were modified using the AvAero system, but the majority were modified with the Nordam hushkit.

Nordam entered the market in 1992 with its first hushkit to allow the 737-200 to meet Stage 3 requirements. In 1994 it certified a low gross weight hushkit (LGW-H), which was capable of bringing most -200 and -200A aircraft with most gross weights into compliance with Stage 3 noise rules, including -9/9A-powered aircraft with a gross weight of up to 122,100lbs, -15/15A-powered aircraft with a gross weight of up to 126,200lbs, and -17/17A-powered aircraft with a gross weight of up to 127,500lbs. This compares to the highest possible gross weight of 128,100lbs.

Although the LGW-H kit does not allow the highest gross weight -15 and -17-powered aircraft to meet Stage 3 noise rules, only a small number of aircraft with gross weights higher than 127,500lbs were built. The number of potential aircraft that the LGW-H kit could not modify was therefore small. Some earlier built -200s had their maximum take-off weights (MTOWs) increased, but they were not hushkitted.

Nordam's customers included Air New Zealand, Alaska Airlines, America West, Delta Airlines, European Aviation, GECAS, Lufthansa, TACA, United Airlines, USAirways and used aircraft later acquired by Ryanair.

The Nordam hushkit is still available, and two new kits were delivered in 2004. Nordam still receives enquiries, since the 737-200 continues to be operated in large numbers in all regions of the world and many aircraft are being traded. The kit is available at a price of about $1 million.

AvAero entered the market in 1994 with a lightweight and heavyweight kit.

Both kits allow -9/9A-powered aircraft operating with an MTOW up to 121,500lbs to meet Stage 3 noise regulations.

The lightweight kit allows -15 and -17-powered aircraft to operate at MTOWs up to 124,500lbs to meet Stage 3 noise rules. The heavyweight kit allows -15-powered aircraft to operate with an MTOW up to 127,500lbs and -17-powered aircraft to operate with an MTOW up to 128,100lbs to meet Stage 3 noise rules.

AvAero's major customers were AirTran, Arkia, Casino Express, L'Aeropostale, Vanguard, WestJet, Southwest and Canadian Airlines.

Performance enhancement

Following its hushkit system, AvAero has developed a drag and fuel burn reduction system, known as a 'Fuelmizer' for the 737-200 & -300. The supplemental type certificate is being extended to include the 737-400 and -500.

The system is an aerodynamic

About 450 737-200s were equipped with Stage 3 hushkits. Two modification programmes are now available that reduce induced drag with the effect of reducing trip fuel burn by the order of 3.0-5.5%. These can also have the effect of improving payloads at hot and high airfields, thus increasing revenue earning capacity. Other major modification programmes are passenger-to-freighter conversions which cost in the region of $1.6-1.8 million.

modification which only works with the flaps fully retracted. The aft segments of the trailing edge flaps are repositioned aft and slightly lower than standard positions when retracted. This increases wing camber and area and lengthens wing chord. The flaps maintain their normal positions when they are loaded. This alteration improves the aircraft's lift-drag ratio, thus reducing drag and fuel burn.

While AvAero already has a STC for its Fuelmizer system, several airlines are testing it on their aircraft.

AvAero has already established that the benefit of the system is to reduce block fuel burn by about 4.3%, thereby saving about 80 USGallons (USG) on a typical 600nm trip. The kit will save about 148,000USG of fuel for each aircraft per year at typical annual utilisation of about 1,800 flight cycles (FC). At current prices of about $1.05 per USG, the kit can save $155,000 in reduced fuel cost per aircraft annually.

This compares to the kit's list price of $125,000. Payback for the installation is thus realised in less than one year at current fuel prices. The only additional costs that have to be considered are man-hours for installation, but because of the kit's simplicity these are low, at only 200-250. Installation can be done at most maintenance facilities and in just two or three days. The system's simplicity means that it also incurs no additional maintenance costs.

As an alternative to AvAero's system, Quiet Wing Technologies has developed a performance kit and winglet system for the 737-200. Operators have the option of having just the performance kit, or performance kit and winglet installed on their aircraft.

The performance kit includes configuration changes to the flap and aileron. In addition, Quiet Wing offers acoustic treatment for the engines, which can make the aircraft compliant with Stage 4 noise rules.

The performance kit reduces induced drag and therefore fuel burn, while the winglet realises a further reduction in wingtip vortice drag and higher reduction in fuel consumption.

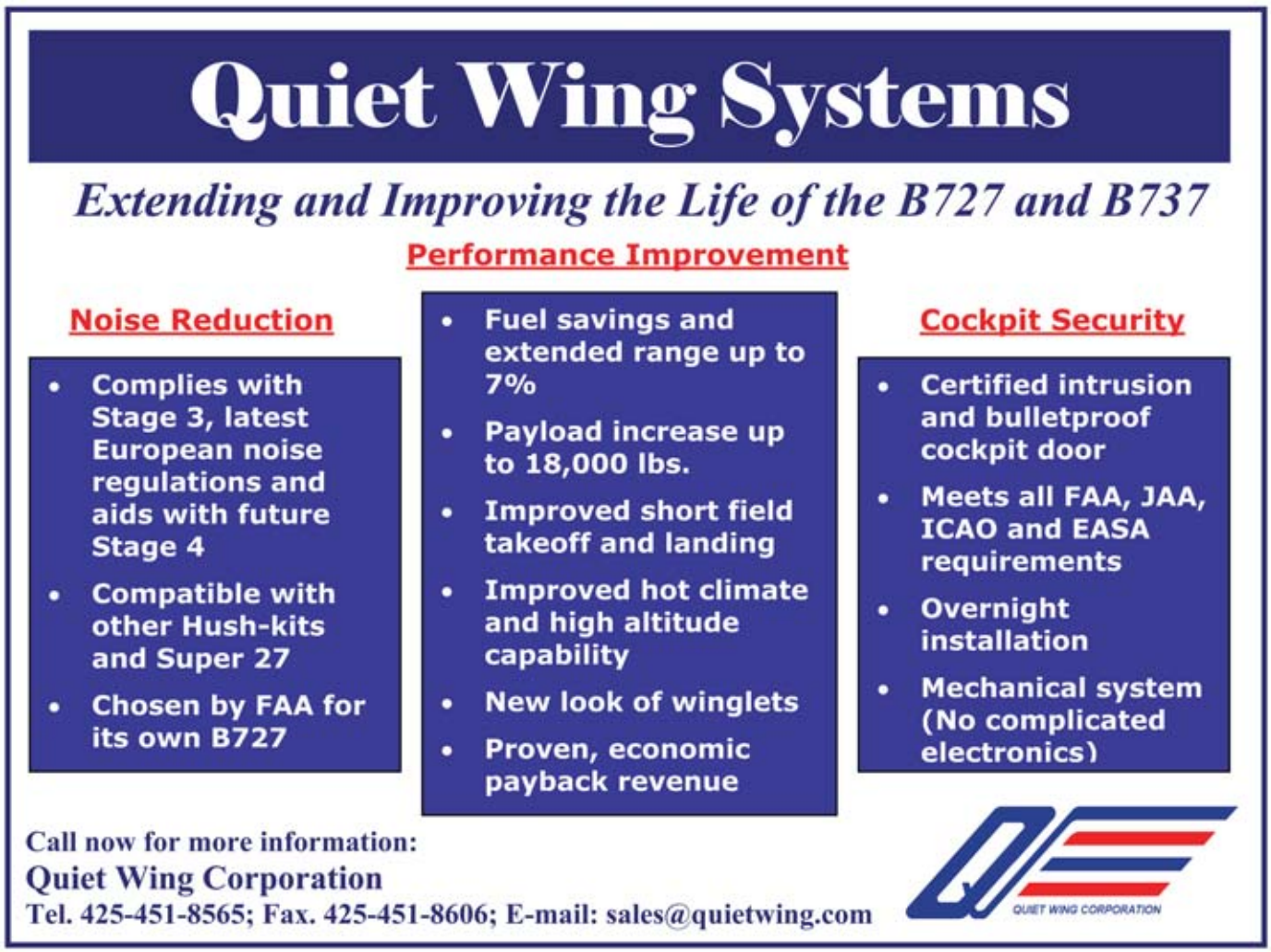
The kit also reduces compressibility drag, and so allows the aircraft to operate a higher cruise speed without a drag penalty.

The performance kit alone achieves a reduction in fuel burn of about 3%, which is equal to about 55USG on a 600nm trip. This saves about 99,000USG each year at an annual utilisation of 1,800FC, and generates a saving of about $104,000 at current fuel prices.

Besides a 3% reduction in fuel burn, the Quiet Wing Technologies performance kit also increases operating performance. The consequences of this are to increase allowable payload at airports or on routes where the aircraft normally experiences a restricted payload. This often occurs when the aircraft operates from hot and high airfields. The kit is known to increase allowable payload by up to 5,000lbs on the most challenging routes.

Even where an additional payload of 3,000lbs were possible on a route, this would translate into a significant increase in revenue generating capacity. This would be equal to up to another 13 passengers or the same weight in freight payload on each flight. An additional 10 passengers paying just $60 for a one-way fare would generate an extra $600 per segment: equal to more than $1 million per year in additional revenue. At a relatively low yield of $0.20 per lb, the aircraft would generate another $600 per flight in freight revenue. Even though an aircraft in a freight operation may only achieve about 800FC per year, the additional payload would be equal to another $480,000 in revenue annually.

List price for the kit is $395,000. A further cost of about 1,200MH for installation, costing about $60,000, has to be considered against this. With fuel savings alone, the payback period for the installation is about five years. Where



737-200F/-200AF FREIGHT PAYLOAD SPECIFICATIONS

Variant	Pemco/Stambaugh 737-200AF	AEI 737-200AF
MZFW-lbs	95,000-96,500	95,000/106,500
OEW-lbs	57,500	59,000
Gross structural payload-lbs	37,500-39,000	36,000/47,500
Maindeck containers:		
	7 X 88/125	7 X 88/125
	1 X 88/108	1 X 88/108
Maindeck container volume-cu ft	3,432	3,432
Underfloor freight volume-cu ft	875	875
Total freight volume-cu ft	4,307	4,307
Container tare weight-lbs	3,200	3,200
Crew weight-lbs	500	500
Net structural payload-lbs	33,800-35,300	32,300/43,800
Maximum packing density-lbs/cu ft	7.8-8.2	8.1/11.0

737-200 operators are experiencing payload limitations, the payback period will be less than a year because of the additional revenue generated. The airline will also benefit from avoiding the need to change aircraft type.

The addition of the winglets to the Quiet Wing Technologies system increases the fuel saving to about 5.5%, while retaining the benefit of improved operating and payload performance. A 5.5% fuel burn reduction saves about 102USG on a 600nm mission, which totals 184,000USG over a year's utilisation. This is equal to about $193,000 at a fuel price of $1.05 per USG.

The list price for performance kit and winglet for the 737-200 is $645,000. Payback for this system on fuel savings will therefore take just over three years, which will decrease to less than a year if the operator benefits from higher payload and revenue generation.

Freighter conversion

There are two major passenger-to-freighter modifications for the 737-200. These are offered by Aeronautical Engineers Inc (AEI) and Pemco Aviation. Installation for the Pemco modification is made by Stambaugh Aviation.

With either conversion, the 737-200 can accommodate seven 88-inch by 125-inch containers and one 88-inch by 108-inch container.

Each 88-inch by 125-inch container has an internal volume of 440 cubic feet, while the smaller container has a volume of 352 cubic feet. This gives the aircraft, after either conversion, a maindeck container volume of 3,432 cubic feet.

The underfloor bulk volume capacity of 875 cubic feet would be added to this, taking total volume to 4,307 cubic feet. This has to be considered against the gross and net structural payload of the aircraft following either conversion.

Following conversion to freighter with the Pemco/Stambaugh modification, the aircraft has an operating empty weight (OEW) averaging about 57,500lbs, after removing items such as toilets, airstairs, potable water, seats and passenger service units. This is a weight reduction down from 60,000-65,000lbs for the passenger variant, and a similar weight for the -200C.

The aircraft has a maximum zero fuel weight (MZFW) of 95,000-96,500lbs, meaning its gross structural payload after conversion will be 37,500-39,000lbs. The actual gross payload capability will depend on the individual aircraft.

The net structural payload will be the gross payload less the tare weight of the eight maindeck containers. Each container has a weight of 400lbs, and so total tare weight will be 3,200lbs. Another 500lbs should be allowed for crew weight. This will leave the aircraft with a net structural payload of 33,800-35,300lbs.

This has to be compared with the total available freight volume of 4,307 cubic feet. The aircraft is therefore capable of a maximum packing density of 7.8-8.2lbs per cubic foot, depending on net structural payload and ultimately OEW.

The list price for Pemco/Stambaugh's conversion is $1.8 million, depending on quantity of aircraft converted. Aircraft owners and operators would be advised to perform a 'D' or heavy C check at the same time to avoid duplication of maintenance items.

AEI's freighter conversion produces an aircraft with similar weight specifications and payload capacity. AEI says aircraft have an average OEW of about 59,000lbs following conversion. Although the MZFW of most aircraft is about 95,000lbs, AEI says it is possible to increase this to up to 106,500lbs during modification to freighter. The aircraft would therefore have a gross structural payload of 47,500lbs. This compares to 36,000lbs for a typical MZFW.

Container tare and crew weight of 3,700lbs should be deducted from this, taking net structural payload down to 43,800lbs for the aircraft with the higher MZFW, and 32,300lbs for the aircraft with the standard MZFW.

Maximum packing density would thus be 8.1lbs per cubic foot and 11.0lbs per cubic foot.

List price for the standard conversion by AEI is $1.6 million.

Other modifications

It is possible to increase the MTOW of the 737-200 with upgrade kits available from Boeing. The ability to increase MTOW is dependent on the wing number, tail number and body number of the aircraft being considered for an upgrade. Enquiries for an increase to MTOW are made to Boeing, which will provide a quote. Generalisations cannot be made on increasing MTOW, although it is widely thought that increasing MTOW is expensive in relation to the age of the aircraft and the likely remaining life.

There are various avionic upgrades that 737-200 operators and owners will have to consider. The installation of equipment for reduced vertical separation minima (RVSM) will already have had to be fitted to 737-200s operating in the Americas, Europe and the Asia Pacific.

Aircraft operating in Europe will have to install the Terrain Awareness & Warning System (TAWS), and aircraft in the US will have to be compliant with this modification by 31st March 2005.

Aircraft operating in Europe will also have to comply with an ATC mode S transponder modification. The cost of this upgrade has to be considered. AC