The ATR 42 and ATR 72 are the most likely turboprop candidates for passenger-to-freighter conversion. Key P-to-F feedstock selection criteria for these aircraft are considered here, including age, accumulated flight cycles and maintenance condition.

Cherry picking ATR 42s/72s for freighter conversion

Turboprops dominate the regional freighter segment, since they provide lower operating costs than regional jets (RJ) on short sectors. Larger turboprops can be split into two sub-categories: 5-7tonne (t) aircraft; and 8t types. Turboprop freighters in these size categories might be used for mail, express or general freight services. There are no new-build 5-7t or 8t turboprop freighters available, but there are a number of passenger-to-freighter (P-to-F) conversion options.

The ATR 42 is the most numerous 5-7t turboprop type in passenger service, and is the only 50-seat example that remains in production. The ATR 72 is the most numerous 8t type. The ATR 42 and ATR 72 will therefore be the main turboprop candidates for P-to-F conversion in the 5-7t and 8t segments in the near to medium term.

ATR says that the ATR 42 and ATR 72 are the only turboprops with a fuselage that is wide enough to accommodate 88-inch X 108-inch containers, and emphasises how the front cargo door, which is standard on all ATR 42s and the vast majority of ATR 72s, lends itself to easier loading for freight operations.

In June 2017 ATR announced that it had created a new Leasing, Asset Management & Freighter department. One of its main functions will be the provision of asset management services, including support for freighter conversions.

The most suitable ATR 42 and ATR 72 conversion candidates are identified here.

Conversion options

Several different model series of the ATR 42 and ATR 72 have been introduced since each type first entered service in the 1980s.

ATR 42

The first commercial variant of the ATR 42 was the ATR 42-300 series, which entered service in 1985. It was followed by the -320 series, which had more powerful engines.

The ATR 42-300/-320 series were superseded by the -500 series, which entered service in 1995, with higher weight options and a further engine upgrade. The most recent variant is the ATR 42-600, which entered service in 2012, featuring more improvements, including new avionics. On its type certificate, the ATR 42-600 is officially recorded as the ATR 42-500 '600 version'. ATR 42-600 is the commercial designation given to an ATR 42-500 that has received ATR's new avionics suite (NAS) modification. ATR 42-600s are unlikely to be considered for P-to-F conversions for another 10 years, since the fleet is too young at this point. They will therefore not be considered as possible conversion candidates in this analysis.

There are P-to-F conversion options available for ATR 42-300/-320 and -500 series airframes. All of these aircraft have the same fuselage dimensions. The -300 and -320 series have the same certified weight options, with a maximum take-off weight (MTOW) of up to 37,257lbs and a maximum zero fuel weight (MZFW) of up to 34,259lbs *(see table, page 85)*. The -300 and -320 series both feature four-bladed propellers, but the -320 has more powerful PW121 engines compared to the -300's PW120s. The ATR 42-500 series has an MTOW of up to 41,005lbs and an MZFW of up to 37,478lbs. ATR 42-500s also feature higher-rated PW127E or M engines and six-bladed propellers.

ATR 72

The -200 series was the first model of ATR 72 to enter commercial service in 1989, followed by the ATR 72-210 series. Both of these model series feature the same weight options but the -210 has upgraded engines.

The ATR 72-500 entered service in 1997 with higher weight options and more powerful engine options. The latest variant is the ATR 72-600, which entered service in 2011 and features upgraded avionics.

The ATR 72-500 and ATR 72-600 are officially referred to as the ATR 72-212A and ATR 72-212A '600 version' on their type certificates. ATR 72-500 and ATR 72-600 are commercial designations. The ATR 72-212A '600 version' is an ATR 72-212A that has been fitted with the NAS modification.

It could be another 10 years before ATR 72-600s begin to be converted into freighters, due to the young age of the active fleet and their popularity with passenger airlines. They will therefore not be considered as conversion candidates in this analysis.

There are P-to-F conversion programmes available for ATR 72-200s, -210s and -500s. All ATR 72s have the same fuselage dimensions. The ATR 72-200 and -210 series both offer an MTOW of up to 48,501lbs and an MZFW of up to 44,092lbs *(see table, page 85)*. Both model series have four-bladed propellers, but the -210 has higher rated PW127 engines compared to the -200's PW124Bs. The ATR 72-500 offers an MTOW of up to 50,705lbs and an

ATR 42/72 BULK FREIGHTER SPECIFICATIONS

Aircraft	ATR 42-300/-320	ATR 42-500	ATR 72-200/-210	ATR 72-500
MTOW (lbs)	Basic: 36,817 Option: 37,257	Basic: 41,005	Basic: 47,399 Option: 48,501	Basic: 48,501 Option 1: 49,603 Option 2: 50,265 Option 3: 50,705
MZFW (lbs)	Basic: 33,510 Option: 34,259	Basic: 36,817 Option: 37,478	Basic: 43,430 Option: 44,092	Basic: 44,092 Option 1: 45,194 Option 2: 45,855 Option 3: 46,296
Bulk cargo volume (cu ft)	1,600-1,978	1,600-1,978	2,250-2,666	2.250-2,666
Max structural payload (lbs)	up to 11,969-12,566	up to 12,367-14,500	up to 17,714-18,959	up to 18,482-19,500

Notes:
1). Max structural payload figures are estimates. These could vary slightly by aircraft owing to different OEWs.
2). Variation in cargo volume and payloads is due to differences between conversion programmes.

MZFW of up to 46,296lbs, and features six-bladed propellers and the option of uprated PW127F or M engine variants.

Conversion type

Two types of P-to-F conversion are available for the ATR 42 and ATR 72: structural tube 'bulk' freighter and large cargo door (LCD) conversions.

Bulk conversions

Bulk ATR freighter conversions typically involve removing the passenger interior and installing a Class E cargo cabin, and a reinforced floor. These conversions do not include the installation of a large cargo door (LCD), and converted aircraft are referred to as bulk freighters. Converted ATR 42 and ATR 72 bulk freighters use their existing passenger and cargo entry doors for loading and unloading freight. ATR points out that the standard forward cargo door installed on ATR 42 and ATR 72 passenger aircraft measures 51 inches X 62 inches and that this is large enough for bulk freighters to accommodate some bespoke containers. Many are bulk loaded, however.

Supplemental type certificates (STCs) for ATR bulk freighter conversions are offered by IPR Conversions, Aeroconseil, which is part of the Akka Technologies group, Aerodisa and Elbit Systems of America. Each provider offers STCs for the conversion of ATR 42-300s, -320s and -500s and ATR 72-200s, -210s and -500s.

An ATR 42 bulk freighter offers 1,600-1,978 cubic feet (cu ft) of cargo volume, depending on the conversion provider *(see table, this page)*. The maximum structural payload is 11,969-12,566lbs for an ATR 42-300 or -320, and 12,367-14,500lbs for a -500 series.

The cargo volume offered by an ATR 72 bulk freighter is 2,250-2,666 cu ft depending on the STC used for the conversion *(see table, this page)*. The maximum structural payload could be 17,714-18,959lbs for a -200/-210 series aircraft, and 18,482-19,500lbs for a -500 series.

IPR Conversions acquired the original equipment manufacturer (OEM) STCs for bulk and LCD ATR freighter conversions from Alenia Aermacchi (now Leonardo) in 2015. At the time, these STCs only covered the conversion of ATR 42-300/-320 and ATR 72-200/-210 airframes. IPR has since been awarded STCs for the bulk and LCD conversion of ATR 42 and ATR 72-500 series aircraft.

An ATR 42 converted to bulk freighter status by IPR would offer a cargo volume of up to 1,978 cu ft. This compares to 2,666 cu ft for an ATR 72 bulk freighter. The maximum structural payload would be up to 11,969lbs for an ATR42-300/-320 and up to 13,098lbs for an ATR 42-500. For ATR 72 bulk freighters, IPR offers maximum structural payloads of up to 17,714lbs for the -200/-210 series aircraft, and up to 18,482lbs for the -500 series. IPR claims its bulk conversions are the only ones that offer window plugs.

An ATR 42 bulk freighter converted under Aeroconseil's STC would provide a cargo volume of up to 1,872 cu ft and a structural payload of up to 12,566lbs. This compares to a volume of 2,650 cu ft and a payload of up to 18,900lbs for an ATR 72 freighter. Currently, Aeroconseil does not offer higher payloads for ATR 42 or ATR 72-500 series airframes. "The loading of the aircraft has an impact on range and we believe our customers do not require additional payload, although if demand arises, we will offer a more resistant floor panel solution" explains Sebastien Ayral, cargo conversion modification project manager at Aeroconseil. "Current capacity requirements prioritise volume over weight and we have practically reached design volume limits."

Aerodisa's ATR 42 conversions offer a cargo volume of up to 1,977 cu ft and a maximum structural payload of up to 12,367lbs for all -300, -320 and -500 series aircraft. Its ATR 72 bulk freighters offer a volume of up to 2,648 cu ft and a payload of up to 18,562lbs for all -200, -210 and -500 series aircraft.

Elbit Systems of America's conversions produce ATR 42 bulk freighters with up to 1,600 cu ft of cargo volume and ATR 72 freighters with 2,250 cu ft of volume. Maximum structural payloads could be up to 12,500lbs for ATR 42-300 and -320 series airframes, and up to 14,500lbs for ATR 42-500s. An ATR 72-200 or -210 converted under Elbit Systems of America's STCs would provide up to 18,750lbs of structural payload, while a -500 series airframe could offer up to 19,500lbs of payload.

Large cargo door conversions

IPR Conversions offers the only LCD modification for ATR 42s and ATR 72s, after acquiring the OEM STCs in 2015. This conversion option involves installing a 116-inch X 71-inch LCD on the left-hand side of the fuselage forward of the wing and is available for ATR 42-300, -320 and -500 series aircraft, and ATR 72-200, -210 and -500 series aircraft. The LCD is 65 inches wider and offers an extra nine inches of height clearance, in comparison to the standard forward

IPR ATR 42 & ATR 72LCD FREIGHTER PAYLOAD SPECIFICATIONS

Configuration	ATR 42-300/320 LCD F	ATR 42-500 LCD F	ATR 72-200/210 LCD F	ATR 72-500 LCD F
Containers	5 LD3	5 LD3	7 LD3	7 LD3
Gross Payload (lbs)	11,389	12,518	17,064	17,832
Total volume (cu ft)	1,240	1,240	1,548	1,548
Total tare weight (lbs)	1,100	1,100	1,540	1,540
Net structural payload (lbs)	10,289	11,418	15,524	16,292
Max packing density (lbs/cu ft)	8.30	9.21	10.03	10.52
Volumetric payload @ 6.5lbs/cu ft	8,060	8,060	10,062	10,062

Configuration	ATR 42-300/320 LCD F	ATR 42-500 LCD F	ATR 72-200/210 LCD F	ATR 72-500 LCD F
Containers	3 (88"x108")+1(53"x88")	3 (88"x108")+1(53"x88")	5 (88"x108")	5(88"x108")
Gross Payload (lbs)	11,389	12,518	17,064	17,832
Total volume (cu ft)	1,525	1,525	1,975	1,975
Total tare weight (lbs)	1,661	1,661	2,295	2,295
Net structural payload (lbs)	9,728	10,857	14,769	15,537
Max packing density (lbs/cu ft)	6.38	7.12	7.48	7.87
Volumetric payload @ 6.5lbs/cu ft	9,728	9,913	12,838	12,838

Configuration	ATR 42-300/320 LCD F	ATR 42-500 LCD F	ATR 72-200/210 LCD F	ATR 72-500 LCD F
Containers	3 ABZ+1(53"X88")	3 ABZ+1(53"X88")	5 ABZ	5 ABZ
Gross Payload (lbs)	11,389	12,518	17,064	17,832
Total volume (cu ft)	1,606	1,606	2,110	2,110
Total tare weight (lbs)	1,718	1,718	2,390	2,390
Net structural payload (lbs)	9,671	10,800	14,674	15,442
Max packing density (lbs/cu ft)	6.02	6.72	6.95	7.32
Volumetric payload @ 6.5lbs/cu ft	9,671	10,439	13,715	13,715

Configuration	ATR 42-300/320 LCD F	ATR 42-500 LCD F	ATR 72-200/210 LCD F	ATR 72-500 LCD F
Pallets	3 (88"x108")+1(53"x88")	3 (88"x108")+1(53"x88")	5 (88"x108")	5 (88"x108")
Gross Payload (lbs)	11,389	12,518	17,064	17,832
Total volume (cu ft)	1,693	1,693	2,230	2,230
Total tare weight (lbs)	1,239	1,239	1,775	1,775
Net structural payload (lbs)	10,150	11,279	15,289	16,057
Max packing density (lbs/cu ft)	6.00	6.66	6.86	7.20
Volumetric payload @ 6.5lbs/cu ft	10,150	11,005	14,495	14,495

Notes:
1). Gross payload assumes Ancra cargo loading system is installed. CLS weight is 580lbs for ATR 42 & 650lbs for ATR 72.
2). Total volume includes bulk volume.
3). Payload figures are estimates and will vary by individual aircraft according to OEW. There may be other MTOWs/MZFWs available and differences related to conversion options.
4). Container & pallet volume and tare weights will vary by manufacturer.

cargo door. An LCD freighter could therefore be loaded with larger items of freight than an aircraft modified to bulk status. The LCD conversion includes the same Class E cabin modification as the bulk conversion, but involves additional reinforcement of the cabin floor. It is sometimes referred to as the 'structural tube' and LCD conversion.

IPR quotes the same maximum structural payloads for ATR LCD freighters as it does for its bulk freighter conversions. Maximum structural payload is calculated by subtracting an aircraft's operating empty weight (OEW) from its maximum zero fuel weight (MZFW). In reality, the installation of the LCD adds about 280lbs to an ATR 42's or ATR 72's OEW, but this is not considered significant since OEWs of individual aircraft can vary by similar levels due to other factors, including: differences between the weight of the crew and their belongings; the weight of baggage and water; and the precise crew accommodation layout.

The installation of an LCD allows ATR freighters to accommodate a wider range of cargoes and permits the use of larger containers and pallets, otherwise known as unit load devices (ULDs). Some of the main ULD loading options have been summarised *(see table, this page)*. These include assumptions regarding ULD volumes and tare weights and the presence and weights of installed cargo loading systems.

An ATR 42 LCD freighter could offer 770-1,136 cu ft of containerised cargo volume or 1,223 cu ft of palletised volume. A further 470 cu ft of bulk loading capacity is available in the rear of the fuselage. The payload available for cargo, also known as the net structural payload, is calculated by removing the weight of any ULDs and cargo loading systems from the maximum structural payload. The net structural payload of an ATR 42-300/-320 LCD freighter could therefore vary from 9,671lbs to 10,289lbs when loaded with containers and would be 10,150lbs when configured with pallets. The net structural payload of an ATR 42-500 LCD freighter would range from 10,800lbs to 11,418lbs when loaded with containers and would be 11,279lbs when configured with pallets.

At a typical express package packing density of 6.5lbs per cu ft (lbs/cu ft), ATR 42-300/-320 LCD freighters would offer volumetric payloads of 8,060-9,728lbs when configured with containers and 10,150lbs when loaded with pallets *(see table, this page)*. ATR 42-500 LCD freighters would offer volumetric payloads of 8,060-10,439lbs or 11,005lbs when loaded with containers or pallets at this packing density.

In reality, very few ATR 42s are likely to undergo LCD conversions, because the difference in acquisition costs between suitable ATR 42 and ATR 72 LCD conversion candidates is relatively small, while the difference in potential cargo volume is quite large. ATR 42s are therefore more likely to be converted into bulk freighters.

Most ATR LCD conversion candidates will be ATR 72s. An ATR 72 LCD freighter can typically accommodate up to five ULDs on its main deck, two more than an ATR 42. An ATR 72 LCD freighter could offer a containerised cargo volume of 1,078-1,640 cu ft, or 1,760 cu ft of palletised volume. The total volume can be increased by a further 470 cu ft, if bulk capacity in the rear of the fuselage is used. The net structural payload of an ATR 72-200/-210 would be 14,674-15,524lbs when loaded with containers and 15,289lbs when configured with pallets. An ATR 72-500 LCD freighter would have a net structural payload of 15,442-16,292lbs when configured with containers and 16,057lbs when loaded with pallets.

ATR 72 LCD freighters would offer a volumetric payload of 10,062-13,715lbs when loaded with containers at a packing density of 6.5lbs/ cu ft *(see table, this page)*. The volumetric payload would be 14,495lbs at this packing density, if they were loaded with pallets. These containerised and palletised volumetric capacities assume that the aircraft are also using the 470 cu ft of bulk volume at the rear of the fuselage.

Airframe selection

Operators or investors may consider a number of different criteria when

identifying potential ATR 42 and ATR 72 P-to-F feedstock candidates, including: age; acquisition and conversion cost; model series; weight specifications; accumulated utilisation; fleet commonality; and maintenance condition. In some cases, the suitability of airframes may depend on whether they are being converted into a bulk or LCD freighter.

Age and cost

Most P-to-F conversions are carried out on feedstock airframes that are 15-20 years of age, regardless of aircraft type.

The acquisition costs for aircraft that are younger than 15 years of age are typically too high for them to be considered for P-to-F conversions. This is because they generally remain in demand with passenger operators, which leads to higher market values. Aircraft that are in excess of 20 years of age will probably have suitable market values, but may not have enough economic life remaining for potential freighter operators to realise a satisfactory return on their investment. This may be due to the aircraft's accumulated utilisation approaching its design limits, or expensive ageing structural maintenance thresholds.

In many cases, the balance between acquisition cost and remaining economic life is optimised when aircraft enter the 15-20 year age range. When a certain fleet begins to age and is replaced by a younger or new-generation model, it may start to be withdrawn from passenger service, leading to a surplus of available used aircraft and, subsequently, a fall in market values. These aircraft could make the ideal conversion candidates, provided they have enough life remaining.

Most ATR 42s and ATR 72s that undergo P-to-f modifications are likely to be 15-20 years old. "We believe this is about the right timeline based on the information and projections that we have available," says Karine Guenan, vice president, leasing, asset management & freighter, customer & structured finance at ATR. "Most conversions will take place in the 15-20-year age window, although there are exceptions," explains Christian Degouy, managing owner, IPR Invest. "We are converting a 30-year-old ATR 42-320 into a bulk freighter and we will convert an eight-year-old ATR 72-500 into an LCD freighter. Converting aircraft this young is unusual, however."

Degouy believes there could be a slight difference in the ages at which ATR freighters are converted, depending on whether they are being modified to bulk or LCD freighter status. "Operators will consider converting older aircraft into bulk freighters, including some airframes that are more than 20 years old, while LCD conversions will only be performed on younger airframes, mostly those that are 15-20 years old," says Degouy. "This is due to the difference in cost between bulk and LCD conversions." IPR's bulk freighter conversions cost $628,000 for an ATR 42 and $698,000 for an ATR 72. This compares to $1.73 million and $1.80 million for ATR 42 and ATR 72 LCD conversions.

The total on-ramp costs incurred to bring a converted freighter into service are the sum of the acquisition, conversion and maintenance costs. *Aircraft Commerce* does not have current maintenance cost data, but it is possible to estimate the cost of acquiring and converting aircraft in half-life maintenance condition. Current market values (CMVs) for typical conversion-age ATR 42s and ATR 72s have been summarised *(see table, page 88)*. If IPR's conversion costs are added to these CMVs, the typical cost of acquiring a half-life aircraft and converting it into a bulk freighter will range from $2.43 to $6.88 million for an ATR 42, depending on the vintage and variant. For an ATR 72 bulk freighter the same costs could total $3.70-7.00 million. For LCD conversions, typical acquisition and conversion costs for half-life aircraft will be $3.53-7.98 million for an ATR 42, and $4.80-8.10 million for an ATR 72.

"Operators will be able to amortise the lower cost of a bulk conversion over a shorter period, so they will not necessarily need an aircraft with as much economic life remaining," explains Degouy. "This means they can choose older, cheaper airframes,"

There is some evidence to support the view that older aircraft will be considered for bulk freighter conversions as operators look to take advantage of the lower acquisition costs of ageing, early-model series aircraft. Aeroconseil has converted 34 ATRs into bulk freighters, including 10 ATR 42s and 24 ATR 72s. Only one of these aircraft was less than 15 years old at the time of conversion, but nine, including three ATR 42s and six ATR 72s, were more than 20 years old. These older aircraft account for 26% of all the ATRs converted by Aeroconseil, including 30% of ATR 42s and 25% of ATR 72s. The oldest converted airframes

ESTIMATED ACQUISITION COSTS FOR HALF-LIFE ATR 42/72

Aircraft	Engine	Aircraft Age	CMV ($-millions)
ATR 42-300	PW120	20 years	1.80
ATR 42-300	PW120	25 years	1.80
ATR 42-320	PW121	21 years	2.00
ATR 42-320	PW121	25 years	2.00
ATR 42-500	PW127	15 years	6.25
ATR 42-500	PW127	20 years	5.25
ATR 72-202	PW124	20 years	3.00
ATR 72-202	PW124	25 years	3.00
ATR 72-212	PW127	21 years	4.00
ATR 72-212	PW127	24 years	4.00
ATR 72-500	PW127	15 years	6.30
ATR 72-500	PW127	20 years	5.30

CMV Source: Oriel

Notes:
1).CMVs are for aircraft in half-life maintenance condition with half-life engines.

were two 23-year-old ATR 72-200s.

Based on the available evidence, this analysis will only consider ATR 42s and ATR 72s that are less than 20 years old as suitable candidates for future LCD conversions. The willingness of operators to select older airframes for bulk freighter modifications, suggests that an increase in the upper age threshold is appropriate for these particular conversions. ATR 42s and 72s that are less than 25 years old are therefore considered the most suitable candidates for future bulk freighter conversions.

Model series

It has already been established that the model series that will be considered for conversion in the near to medium term are the ATR 42-300, -320 and -500, and the ATR 72-200, -210 and -500. All of these model series can be considered for conversion to some extent, although some sub-variants are less suitable than others and the different generations offer slightly contrasting advantages.

ATR 42-500s and ATR 72-500s offer superior hot-and-high take-off performance and slightly higher payloads compared to the early-generation model series, due to improved engines and higher certified weight options.

Degouy suggests that freight operators might opt for ATR 42-300s/-320s or ATR 72-200s/-210s, if they do not require the superior performance of -500 series aircraft, due to the older models' lower acquisition and operating costs. "An ATR-72-200 offers 8% lower direct operating costs (DOCs) per flight hour (FH) than a -500 series and its engine maintenance costs are $100 less per FH," claims Degouy. At the same time, Degouy acknowledges that there are certain drawbacks associated with the ageing model series. "ATR freighter operators are selling their on-time performance (OTP) capabilities to the market, especially when they are targeting express, integrator services," says Degouy. "As aircraft age, their dispatch reliability can decrease, making it harder to maintain OTP. It is certainly becoming more challenging for an ATR 72-200 to maintain the same levels of OTP as a younger -500. One reason for this is spares availability, with fewer spares becoming available for the older model series. A particular issue affecting the ATR 72-200 is a lack of spare propeller blades for its PW124B engines," continues Degouy. "Overhaul and acquisition prices for these blades are also becoming an issue. While this is not yet a deciding factor in the feedstock selection process, it will eventually drive more operators towards the ATR 72-500."

Degouy also points out that the age profile of ATR 42-300s/-320s and ATR 72-200s/-210s could mean fewer are selected for conversion. "The ageing nature of some model series may make operators think twice about certain conversion options," says Degouy. "Depending on the type of conversion and the operator's amortisation policy, some early model series airframes might be considered too old for an LCD installation."

The ATR 72-200 and -210 series each have two sub-variants: the -201 and -202 and the -211 and -212. The ATR 72-202 and -212 are fitted with the standard forward cargo door, but the -201 and -211 were manufactured with a forward passenger door instead. "Those aircraft with a smaller forward door would be more limited as bulk freighters," explains David Rodenas, chief executive officer at Aerodisa. Since bulk ATR 72 freighters rely on their existing entry doors for cargo loading, those with the smaller forward passenger door would be more restricted in terms of the size and dimensions of the items they could accommodate.

ATR 72-201s and -211s are therefore not considered suitable for bulk cargo conversions, but they are considered suitable for LCD conversions since the small forward door would be replaced by the LCD. Only a small number of ATR 72-201s and -211s were produced, so few are likely to become conversion candidates. There are no variant-specific restrictions concerning the conversion of ATR 42-300s, -320s, -500s; or ATR 72 -202s, -212s and -500s.

Weight specifications

There are several certified weight options available for each of the main ATR model series. The main weight options have been summarised for ATR 42-300s, -320s and -500s; and ATR 72-200s, -210s and -500s *(see table, page 86)*. In most cases these involve multiple MTOWs and MZFWs, although only one MTOW is available for the ATR 42-500. Some reduced weight options may also be available and operators should contact ATR for details. Some MLW upgrades are also available. ATR should be contacted for confirmation of the precise combination of MTOWs and MZFWs that are permitted for each model series.

Degouy points out that most freight operators prefer feedstock aircraft that have the potential to be upgraded to the highest weight specifications, since these would offer the most flexibility for future operations. "Aircraft being used for express operations might use up their available volume before all the payload has been utilised, but it is still preferable to have the highest possible weight specifications to allow flexibility for charter operations," says Degouy. "Charters might involve the carriage of heavy bulkier general freight items."

The certified weights of incoming ATR 42 and ATR 72 P-to-F feedstock will vary. All ATR 42-300s, -320s and -500s, and ATR 72-200s, -210s and -500s can be upgraded to the highest possible weights for each model series, although for some MSNs, these upgrades can lead to operational restrictions. Depending on the feedstock aircraft's incoming specifications, weight upgrades may be as straightforward as a paperwork change, or structural

modifications may be required.

ATR lists several examples of weight modifications that require more than a paperwork change. Upgrading an ATR 42-500's MFZW to the highest possible level of 37,478lbs can only be achieved through structural reinforcement of the fuselage. An upgrade to the highest MTOW of 48,501lbs for the ATR 72-200/-210 can only be achieved through reinforcement of the outer wing. To increase the ATR 72-500's MTOW and MZFW to 50,265lbs and 20,800lbs, Michelin tyres need to be fitted on the nose landing gear. To increase the MTOW and MZFW to the maximum permissible weights of 50,705lbs and 46,297lbs, ATR 72-500s require Mod 4440, which includes structural reinforcement of the fuselage and replacement of the standard vertical tail fin with a carbon fibre alternative. ATR says that the carbon fibre tail fin has been produced as standard since 1997.

ATR highlights one operational restriction related to weight upgrades, which applies to a small number of older ATR 42-300/-320 series aircraft. All of these aircraft can be upgraded to the highest MZFW of 34,259lbs, but those manufactured before MSN 70 would have a maximum speed or VMO restriction of 230 knots calibrated airspeed (KCAS) applied. This is 20 KCAS slower than the standard VMO. Aircraft from MSN 70 onwards are not affected. Few pre-MSN 70 aircraft remain in service and those are more than 30 years old, so this operational restriction is unlikely to be a factor in future feedstock selection decisions.

All ATR 42 and ATR 72 paperwork and structural weight upgrades require a service bulletin (SB) to be bought from the manufacturer. Interested parties should contact ATR regarding eligibility, and for technical and cost information.

Accumulated utilisation

The design service goal for all ATR 42 and ATR 72 variants is currently 70,000 flight cycles (FC). This means their current economic life is limited to a maximum of 70,000 accumulated FC.

Only aircraft that are not expected to exceed 70,000FC of accumulated utilisation during their economic lifespans, are considered suitable conversion candidates in this analysis. To identify which aircraft will meet these utilisation requirements, it is necessary to establish the number of years of post-conversion service that would typically be expected of ATR 42 and ATR 72 freighters, plus their average annual utilisation in terms of FC.

One operator of ATR bulk freighters, converted under the Aeroconseil STC, says that the expected lifespan of their aircraft can vary according to market conditions and the age and status of the aircraft at the time of conversion, along with the level of investment. It adds that the on-going condition of the aircraft and its associated maintenance costs would also be a factor.

Degouy at IPR highlights how the number of years of post-conversion service will depend on the investor's depreciation policy. He suggests that operators typically choose to amortise the on-ramp costs of their ATR freighters over a period of 10-20 years.

This analysis assumes that operators will need up to 20 years of post-conversion use from their ATR bulk and LCD freighters. This is a cautious assumption, since it is unlikely that any converted ATR freighters will operate for more than 20 years, and in some cases they may be withdrawn sooner. This is particularly true for bulk freighters, which could be older at the time of conversion and which may not need to be in service for as long as LCD freighters. This is because their lower on-ramp costs mean they could realise a return on investment sooner than LCD freighters.

The typical annual utilisation of an ATR freighter could vary depending on the type of freight it is carrying, and the

IPR offers the only LCD freighter conversions for ATR 42s and ATR 72s. An ATR 72 LCD freighter can accommodate up to five main deck ULDs. The majority of LCD conversions over the next 10 years are likely to be performed on ATR 72-500s.

region in which it is operating. One ATR cargo operator, whose aircraft were modified under the Aeroconseil STC, says that its ATR 42 and ATR 72 bulk freighters operate low-utilisation overnight freight services on behalf of a major express package carrier. This results in an average annual utilisation of 460FC and 750 flight hours (FH) for its ATR 42s, and 420FC and 700FH for its ATR 72s. Another Aeroconseil customer expects an annual utilisation of 670FC and 1,300FH in 2017 for its ATR 72 bulk freighters. ATR believes that the average annual utilisation across the ATR freighter fleet is 600FC and 600FH. IPR suggests that typical annual utilisation of ATR freighters on intra-European services would be 700FC and 1,000FH, but adds that this could increase in other regions.

This analysis assumes that ATR 42 and ATR 72 freighters will typically operate a maximum of 700FC per year. This is a cautious assumption based on the available evidence, which suggests it is unlikely that many ATR freighters will exceed this level of annual utilisation.

Based on the assumptions used here, an ATR freighter will have to operate up to 700FC per year for 20 years following P-to-F conversion. Over a 20-year period an ATR freighter would be expected to operate up to 14,000FC. In terms of utilisation, the most suitable ATR 42 and ATR 72 conversion candidates are those that have accumulated 56,000FC or fewer. These aircraft should not exceed the current 70,000FC design service goal during their expected service lives.

Fleet commonality

Fleet commonality might be a high-priority selection consideration for operators looking to acquire multiple ATR freighters.

Selecting 'sisterships' could reduce maintenance costs for fleet operators. Sisterships are groups of aircraft that have been in operation with the same carrier. This means they will have been operated in accordance with uniform standards and maintenance procedures. In most cases they will have been exposed to similar environmental conditions. Sisterships will typically have the same components and modification statuses.

Selecting sisterships can save costs associated with spares and personnel training and any maintenance planning issues associated with different modification statuses. If a fleet of aircraft has the same components, there is no need for multiple spares inventories.

Maintenance condition

An aircraft's maintenance condition is another important consideration when selecting feedstock for P-to-F conversions.

Many freighter operators or owners put their aircraft through a heavy maintenance visit in parallel with a conversion. P-to-F conversions and base maintenance checks both require deep access to the aircraft's structure. Preparing the aircraft and carrying out the tasks needed to provide deep structural access can consume a significant number of man-hours (MH). Combining a base maintenance check with the conversion process can subsequently minimise aircraft downtime and the unnecessary duplication of access MH. "For an ATR 42 or ATR 72, 100-150 of access MH could be saved by combining the conversion with a base check," says Joerg Peters, director of maintenance, at Rheinland Air Service (RAS).

Potential ATR 42 and ATR 72 freighter operators may therefore wish to select feedstock airframes that are approaching a heavy maintenance check.

The ATR 42 and ATR 72 have similar maintenance tasks, but the ATR 72 has 10% more tasks in its maintenance planning document (MPD). Some tasks also take longer to perform on the ATR 72 due to its longer fuselage structure. ATR 42s and ATR 72s have a base check cycle of four checks, with a base check interval of 5,000FH. Applying the average utilisation of passenger operators would result in base checks being carried out every 30-32 months. In reality, most ATR 42 and ATR 72 operators perform base checks at shorter, two-year intervals, to bring them in line with four main groups of calendar tasks (*see ATR 42/72 airframe maintenance, Aircraft Commerce, February/March 2016, page 44*). These 2-year (2YE), 4YE, 8YE and 12YE calendar tasks require deep access and include corrosion inspections. Bringing the base check intervals in line with these calendar tasks helps to optimise aircraft downtime and access MH. The two-year base check interval results in a full base check cycle being completed every eight years. The fourth or last check in the cycle has the largest number of tasks and is therefore the heaviest check.

In addition to its standard MPD intervals, ATR also offers the option of a low utilisation recommendation (LUR). The LUR is designed for ATR 42s and ATR 72s with an average annual utilisation of 500FH/750FC and 1,250FH/1,875FC. Many ATRs are likely to qualify for the LUR following P-to-F conversion, requiring operators to adjust their maintenance schedules. "Where applicable, operators will need to adjust the maintenance programme according to the ATR low-utilisation MPD schedule,"

says Peters. "This will basically see several tasks moved from FH intervals in the standard MPD, to calendar intervals under the LUR."

Operators need to consider ageing aircraft maintenance issues when choosing ATR 42 and ATR 72 feedstock for P-to-F conversion. Peters says that in common with most passenger aircraft, ageing ATRs can be prone to corrosion around insulation blankets, toilet modules, galleys and seat tracks. Peters points out that, once converted, ATR freighters will be less susceptible to some of these corrosion areas, since their insulation blankets, galleys and toilets tend to be removed. This analysis does not rule out individual aircraft as conversion candidates based on potential corrosion, since the presence, severity and subsequent rectification costs, will vary from aircraft to aircraft.

Other ageing ATR maintenance requirements relate to fatigue inspections. There are sampling tasks related to fatigue checks, with initial thresholds of 18,000FC, 24,000FC and 36,000FC. Repeat intervals are between 3,000FC, 6,000FC, 9,000FC and 12,000FC. These sampling tasks, which include non-destructive tests (NDTs), can require significant preparation and access MH, but initially, they will only need to be completed on some of an airline's fleet. It is only if defects are found that the remainder of the fleet will need to be inspected. The exact percentage of the fleet that will need to undergo initial testing is agreed with an operator's local aviation authority, but it is typically about 20%. The largest group of these sampling tasks first come due at 36,000FC. *Aircraft Commerce* has been informed that the 184 sampling tasks that come due at this threshold require 110MH for access and more than 400MH for labour. Based on typical utilisation, the 36,000FC tasks are often performed in the last and largest base check, at the end of the second check cycle, when aircraft are 16 years old.

The potential maintenance costs associated with the extensive 36,000FC fatigue sampling requirements might put some investors or operators off feedstock aircraft that are approaching this utilisation threshold. This analysis, however, does not consider the sampling requirements to be a decisive factor in the feedstock selection process. Associated costs will vary by individual fleets and aircraft. Peters also points out that freighters operating under the LUR will fly fewer FC per year than regular airline passenger operations. This means aircraft converted before accumulating 36,000FC will take longer to reach this inspection threshold. In addition, Flight's FleetsAnalyzer shows that 108 active passenger-configured ATRs and 47 freighters have already passed the 36,000FC threshold. This suggests that many operators did not encounter defects or rectification costs that were significant enough to retire their aircraft.

Operators should also be aware of any airworthiness directives (ADs) or SBs affecting ATR 42s and ATR 72s, when considering conversion candidates. *Aircraft Commerce* did not identify any ADs or SBs that would affect an aircraft's suitability for P-to-F conversion.

In addition, operators should research a feedstock aircraft's previous maintenance or operating environment. Peters highlights how aircraft that have been operated in harsh, humid and/or salty environments, can suffer more from corrosion, while those that have been flown at a high FC rate may have more structural fatigue issues.

Another issue raised by a current ATR freighter operator and a customer of the Aeroconseil STC, is that some older feedstock airframes may need significant investment to upgrade their avionics, depending on the region they will be operating in.

Suitable aircraft

The two critical selection criteria to consider when identifying ATR 42 and ATR 72 feedstock candidates for P-to-F conversion are the aircraft's accumulated FC and its age. Those seeking ATR 72s for bulk freighter conversions may also wish to place extra emphasis on the precise sub-variant, since a small number of aircraft were manufactured with forward passenger doors, making them less suitable for freight loading.

The priority assigned to other selection criteria, including weight specifications, fleet commonality and maintenance condition, could vary according to operator requirements.

Aircraft Commerce has applied the two main selection criteria to the active and parked fleet of ATR 42-300s, -320s and -500s; and ATR 72-200s, -210s and -500s. Each aircraft's age and accumulated utilisation is based on data exported from Flightglobal's FleetsAnalyzer on 31st August 2017.

Airframes that have accumulated 56,000FC or fewer are considered to be most suitable candidates for conversion from a utilisation perspective. When this threshold is applied to the ATR 42 fleet, only one -300 and six -320 aircraft are excluded as conversion candidates. No ATR 42-500s are excluded, since the highest accumulated FC among that series is only 49,000FC. Applying the same 56,000FC threshold to the ATR 72 fleet results in four ATR 72-200s being excluded as conversion candidates. No ATR 72-210s or -500s are excluded, since the highest accumulated utilisation among those series is only 54,000FC and 50,000FC.

The remaining conversion candidates are then filtered by age. Aircraft up to 25

ATR BULK FREIGHTER CONVERSION CANDIDATES

Aircraft variant	15-25-years-old August 2017	All aircraft August 2017
ATR 42		
ATR 42-300 Active	7	7
ATR 42-300 Parked	2	2
ATR 42-320 Active	17	17
ATR 42-320 Parked	7	7
ATR 42-500 Active	59	95
ATR 42-500 Parked	11	14
Total	**103**	**142**
ATR 72		
ATR 72-200 Active	14	14
ATR 72-200 Parked	9	9
ATR 72-210 Active	16	16
ATR 72-210 Parked	10	10
ATR 72-500 Active	64	288
ATR 72-500 Parked	19	51
Total	**132**	**388**
All Aircraft		
Active total	177	437
Parked total	58	93
Total	**235**	**530**

Notes:
1). Fleet data source: Flightglobal FleetsAnalyzer. Fleet data correct as of 31st August.
2). All aircraft column figures include airframes up to a maximum of 25-years-of age.
3). Figures show all aircraft with fewer than 56,000FC.

ATR LCD FREIGHTER CONVERSION CANDIDATES

Aircraft variant	15-20-years-old August 2017	All aircraft August 2017
ATR 42		
ATR 42-300 Active	1	1
ATR 42-300 Parked	0	0
ATR 42-320 Active	0	0
ATR 42-320 Parked	0	0
ATR 42-500 Active	44	80
ATR 42-500 Parked	9	12
Total	**54**	**93**
ATR 72		
ATR 72-200 Active	5	5
ATR 72-200 Parked	0	0
ATR 72-210 Active	0	0
ATR 72-210 Parked	0	0
ATR 72-500 Active	63	287
ATR 72-500 Parked	19	51
Total	**87**	**343**
All Aircraft		
Active total	113	373
Parked total	28	63
Total	**141**	**436**

Notes:
1). Fleet data source: Flightglobal Fleets Analyzer. Fleet data correct as of 31st August.
2). All aircraft column figures include airframes up to a maximum of 20-years-of age.
3). Figures show all aircraft with fewer than 56,000FC.

years of age are considered to be the most suitable candidates for bulk conversions. Those that are 20 years old or younger are the best candidates for LCD conversions. There are 27 ATR 42-300s, 26 ATR 42-320s and eight ATR 72-200s that are more than 25 years old. These aircraft are therefore excluded as conversion candidates. The 20-year age restrictions exclude 35 ATR 42-300s, 50 ATR 42-320s, 17 ATR 42-500s, 27 ATR 72-200s, 26 ATR 72-210s and one ATR 72-500 as LCD conversion candidates.

Once ATR 72 bulk conversion candidates have been filtered by accumulated FC and age they can also be filtered by specific sub-variant. ATR 72-201s and -211s are not considered suitable for bulk conversions due to their forward passenger doors. Only one ATR 72-201 aircraft is excluded on this basis, after the utilisation and age filters have been applied.

The aircraft considered most suitable for conversion, after application of the principal selection criteria, are summarised here. The feedstock summary splits aircraft into separate ATR 42 and ATR 72 fleets and then into further sub-fleets according to whether they are suitable for bulk or LCD conversions, to help operators identify those feedstock aircraft most suited to their needs. The largest current passenger operators are identified for each sub-fleet, to identify the potential for fleet commonality.

The following feedstock summary identifies aircraft that are within the typical conversion age ranges of 15-25 years for bulk conversions, and 15-20 years for LCD conversions. Younger aircraft are also considered since these will represent future conversion candidates, but the -600 series ATR 42s and ATR 72s are excluded.

ATR 42 bulk freighter candidates

There are 142 active and parked ATR 42s that meet the two priority feedstock selection requirements for bulk freighter conversions *(see table, page 91)*. These include nine ATR 42-300s, 24 ATR 42-320s and 109 ATR 42-500s.

Calm Air (2 aircraft) and Kalstar Aviation (2) operate the largest fleets of suitable ATR 42-300s, while Buddha Air (3), Alliance Air (2), Lease Fly (2) and Overland Airways (2) have the largest fleets of suitable -320 aircraft. The largest operators of suitable ATR 42-500 aircraft are HOP! (11), Aeromar Airlines (7) and TAROM (7).

All of the ATR 42-300 and -320 candidates are already within the 15-25-year age range suitable for bulk freighter conversions. There are currently 70 ATR 42-500s of the appropriate age. All of the HOP!, Aeromar Airlines and TAROM aircraft are already 15-25 years of age.

ATR 42 LCD freighter candidates

There are 93 active and parked ATR 42s that meet the utilisation and age requirements for LCD conversions *(see table, this page)*. All these aircraft are ATR 42-500s with the exception of a single -300 operated by Kalstar Aviation. The largest operators of suitable ATR 42-500s are HOP! (7), TAROM (7), EasyFly (6), First Air (5), Pakistan International Airlines (5) and NordStar (5).

The single ATR 42-300 and 53 of the ATR 42-500s are already within the 15-20 year age range considered suitable for LCD conversions. The largest operators of these ATR 42-500 airframes are HOP! (7), TAROM (7) and First Air (5).

ATR 72 bulk freighter candidates

Up to 388 active and parked ATR 72s are considered suitable for future bulk freighter conversions. These include 23 ATR 72-200s, 26 ATR 72-210s and 339 ATR 72-500s *(see table, page 91)*.

The largest operators of qualifying ATR 72-200s are Overland Airways (3) MAP Linhas Aéreas (2) and Trigana Air (2), while Island Air (5), Cubana (4) and Iran Aseman Airlines (4) have the largest fleets of ATR 72-210 candidates. The largest operators of qualifying ATR 72-500 candidates are Wings Air (20), Jet Airways (15) and UTair (15).

All of the ATR 72-200 and -210 series candidates already fit within the typical bulk-conversion age range of 15-25 years. About 24% of the ATR 72-500s are currently within this typical age range. This is equivalent to 83 airframes, the largest operators of which are Air Algérie (8) and Mount Cook Airline (8).

ATR 72 LCD freighter candidates

Up to 343 active and parked ATR 72s are considered suitable for future LCD freighter conversions, including five ATR 72-200s and 338 -500 series aircraft *(see table, this page)*.

MAP Linhas Aéreas is the largest operator of qualifying ATR 72-200 series candidates with two aircraft. All five ATR 72-200s are already within the 15-20-year age range typical for LCD conversions.

The largest operators of suitable ATR 72-500 LCD conversion candidates are Wings Air (20), Jet Airways (15) and UTair (15). About 24% or 82 of the ATR 72-500 LCD candidates are already within the typical conversion age window of 15-20 years. The largest operators of conversion-age airframes are Mount Cook Airways (8), Air Algerie (8), and Air KBZ (5). - *NMP* AC