

The A320 family is now the second most numerous aircraft in operation. The consequence of this that it represents the second largest maintenance market for commercial aircraft. The annual volume of base checks, engine events and heavy component maintenance volume is examined.

A320 family maintenance market

The A320 family is ubiquitous, with more than 4,100 in operation; making it the second most numerous aircraft in service. This means it also represents one of the largest maintenance and support markets in the industry.

The family comprises four different-sized variants: the A318, A319, A320 and A321. The seat capacities range from 107 for the A318 to 185 for the A321. All four variants have a high degree of component, engine and structural commonality, so they are treated as a single type for maintenance purposes.

Current fleet

The geographic split of the A320 family operational fleet is about 1,661 aircraft (40%) in Europe, 1,020 aircraft (25%) in the Asia Pacific, and 843 (20%) in North America. South America, the Middle East and Africa each operate the remaining 326, 186 and 95 aircraft.

According to ACAS's March 2010 data, only 100 of the 4,131 aircraft in operation are parked. The majority of A320s are flown by national carriers and low-cost carriers (LCC).

US Airways is the largest operator, with 215, followed by easyJet (178) and United Airlines (152). Air France has 148 aircraft covering six different variants. China Southern is fifth, with 139 aircraft, followed by Delta Air Lines (126), China Eastern (115), TAM Linhas Aereas (109), Lufthansa (102).

Iberia, Air India, Air Canada, British Airways, Alitalia, Air China, Aeroflot-Russian Airlines, and Mexicana have fleets comprising fewer than 100.

The A320 family fleet now exceeds 4,000 units. Current rate of production is 350-400 aircraft per year, and there are 2,000 outstanding firm orders. The fleet will reach at least 2,000 by 2019.

Future fleet

There are more than 2,000 A320 family aircraft on firm order. So far, engine selections have been made for 1,750 of these aircraft. The CFM56 has been chosen for 800, and the V2500 for 950. At the current rate of production this is equal to five or six years' manufacturing. These aircraft on order are to be delivered up to 2019, meaning that by 2020 the A320 Family fleet will have increased by 50% to at least 6,000 units, assuming all current aircraft remain operational. The oldest A320 aircraft would therefore be viable at 30 years old.

There are just 11 orders for the A318. It is unlikely that more will be ordered.

There are 305 outstanding orders for the A319 with deliveries up to and including 2018. Europe has orders for 117, while there are 83 and 60 for North America and South America respectively. Other orders are from the Asia Pacific and the Middle East. easyJet has placed

the largest order of 53 deliveries from 2010 to 2012.

The A320 has an order backlog of 1,829, due for delivery from 2010 to 2019. The largest portion of these orders is for carriers in the Asia Pacific, with a big proportion going to China. Europe comes second with just over 400 aircraft. In particular, Wizz Air will add 112 aircraft over the coming years.

The Middle East will have over 200 deliveries over the next 10 years, with 45 going to Air Arabia. India will see substantial growth in its A320 family fleet. Kingfisher Airlines alone will gain 64 aircraft over the next five years and IndiGo are awaiting 70 A320s. Air Asia is due to gain a huge number of aircraft over the coming few years, with 105 orders still outstanding. Tiger Airlines in Singapore is due an additional 50 aircraft.

In North America US Airways, United Airlines and jetBlue all have A320-232s on order. African carriers have 42 on



A320 GLOBAL FLEET

Aircraft Variant	Africa		Asia Pacific		Europe		Middle East		N. America		S. America		Aircraft sub-total
	Active		Active	Parked	Active	Parked	Active	Parked	Active	Parked	Active	Parked	
A318-111					22				9		9	1	41
A318-112			2		6	1	4	1					14
A318-121											15		15
A318 Total			2		28	1	4	1	9		24	1	70
A319-111	3		16		252		2		33				306
A319-112	4		59	1	114	3	4		72	2	28		287
A319-113					9								9
A319-114	3				41				90				134
A319-115	3		42	1	26	3		2	1		4		82
A319-131	11		15		46				55				127
A319-132			65		44		6		65		60		240
A319-133			22	1	6	1	5	1			13	1	50
A319 Total	24		219	3	539	7	17	3	316	2	105	1	1,236
A320-111					5	2							7
A320-211	16		25		102	14	8		58	6			229
A320-212	4		4		31	4	13		44	9			109
A320-214	18		220		370	2	69		62	3	68		812
A320-216			65		45								110
A320-231	8		44	4	14	6			14	5	29	1	125
A320-232	10		230		170	11	48		244	2	48		763
A320-233	4		22		14	1			5		38		84
A320 Total	60		610	4	751	40	138		422	30	183	1	2,239
A321-111					17	1							18
A321-112					23								23
A321-131			13		24								37
A321-211	7		34		88		3		43	1	1		177
A321-212					21								21
A321-213			21										21
A321-231	4		106		106	3	20		20		10		269
A321-232			7	1	12								20
A321 Total	11		181	1	291	4	23		63	1	11		586
A320 Family Geographical sub-totals	95		1,012	8	1,609	52	182	4	810	33	323	3	4,131
sub-totals	95		1,020		1,661		186		843		326		4,131

order.

There is currently an order backlog of 191 A321s, including 84 for the Asia Pacific, which are all due for delivery by the end of 2016. Europe will gain from many large operators adding a few aircraft to their fleet. Lufthansa will add 19 aircraft and Aeroflot will add 10. The Middle East's increase will come mostly from Saudia's backlog of 15 aircraft. In North America the orders are spread around many current operators.

Outstanding orders for Europe and North America are misleading, since many lessors are based in these locations.

Maintenance programme

The size of the A320 family maintenance market is determined by two key factors: fleet size; and the intervals for the maintenance programme and checks.

The original maintenance planning document (MPD) of the A320 family is over 20 years old. It has evolved, however, and the 33rd revision was issued in May 2010. The check intervals have been extended with extensive operator experience, clearly contributing to a reduction in the aircraft's airframe-related maintenance costs.

Operators have also evolved their own maintenance programmes. "The TAP Air Portugal A320 operator-approved maintenance programme

(OAMP) is in sync with the latest issue of the MPD," says Mario Araujo, engineering vice president at TAP Air Portugal. "There is a maximum tolerance of four months in accordance with written maintenance quality policy rules. The MPD is the main source document for each revision of the customised OAMP. This reflects all inputs and changes based on the in-service experience. The latest MPD issue reflects changes on the MRB Revision 15, which dates from late 2009."

Even the largest operators do not always perform all their own base checks in-house. easyJet, for example, sub-contracts all its maintenance to SR Technics. The largest fleet is operated by US Airways, which sub-contracts its C checks and heavy checks to various North American maintenance, repair & overhaul (MRO) facilities.

The A320 maintenance programme includes an A check cycle and an independent base-check cycle. The base-check cycle comprises eight checks. The basic interval of base-check tasks, 1C tasks, has intervals of 6000FH or 20 months. The C1 check, comprising the 1C tasks, is performed when the first of these intervals is reached. There are three other multiples of these tasks: the 2C, 4C and 8C tasks. Their intervals are corresponding multiples of the basic 1C interval.

Monarch Airlines follows a customised maintenance programme. "Experience can extend check intervals, while problems can reduce them," explains Derek Gibson, sales and marketing director for Monarch Aircraft Engineering (MAEL). "Experience can show that a check done slightly earlier can nip a lot of problems in the bud and save excessive work later."

Large operators and maintenance providers will build up a lot of experience of findings and non-routines on routine task cards, which can result in intervals being extended or shortened. Smaller operators can gain experience and cost savings by having their aircraft maintained by these larger companies, and piggybacking their MPD. "Smaller operations can learn from MAEL, which can manage their schedule using a bigger bank of experiences," says Gibson.

The A320 family maintenance market will grow over the next 10 years, and the intervals are also likely to continue to increase. "Western Europe is definitely the region where fleet growth and the largest number of checks will be seen," says Carlos Ruivo, marketing and sales vice president for TAP Air Portugal Maintenance & Engineering. This is partly due to the local fleet increasing and also due to a number of major MRO facilities being in Europe. Ruivo adds that the maintenance market is likely to



stabilise from 2015 to 2018 in Western Europe. It could pick up again, depending on order levels and the number of older A320s phased out of service.

Line & A checks

Line checks must be carried out wherever the aircraft happens to be on the ground. Daily and weekly checks are an essential part of line maintenance, as are A checks. A checks are the most likely maintenance to be completed in-house.

Line maintenance is often provided by local suppliers, with carriers having reciprocal arrangements for unforeseen issues down route. The many global operators that offer third-party line maintenance services include Air Berlin, Air France (AFI), Alitalia, All Nippon Airways (ANA), Austrian Airlines, British Airways, Delta Airlines (Delta Tech Ops), Iberia, Lufthansa (Lufthansa Technik), Mexicana, Monarch Airlines, South African Airways, TAP Portugal, THY, and UA (United Services). These can be as simple as a turnaround check.

Up to the 27th revision of the MPD, A check task intervals were grouped together and expressed in multiples of 500FH. The 1A tasks had an interval of 500FH, the 2A an interval of 1,000FH and the 4A an interval of 2,000FH.

Francisco Javier Jimenez Aguilar, central production planning at Iberia, explains that at the 28th revision of the MPD released in 2004, the system was changed so that the system tasks were expressed in multiples of 600FH and 750FC, while zonal tasks were expressed in multiples of 100 days. These two groups of task could be grouped together in a single check, or performed separately according to an airline's requirements.

There are still three groups of multiples: the 1A at 600FH, 750FC and 100 days; the 2A at 1,200FH, 1,500FC and 200 days; and the 4A at 2,400FH, 3,000FC and 400 days. Since most operators have similar rates of utilisation and FH:FC ratios, the system and zonal tasks are still grouped together into generic A checks.

Customised A check intervals are as high as 750FH for Aegean Airlines & LAN Airlines (and their associated airlines), and 800FH for Swiss, while Cebu Pacific Air has a reduced A check interval of 200FH, 250FC or 33 days due to its short average FC time (no more than 1.5FH) and high daily utilisation (averaging 11FH). TAP Air Portugal has the higher interval of 750FH or four months, whichever is reached first. Araujo adds that A check type tasks are arranged into four block checks: the A1, A2, A3 and A4 checks.

C checks

Base checks include 'C' checks, heavy 'C' checks, and structural inspections. The heavy C checks and structural inspections are more likely to be undertaken by a third-party maintenance facility in the case of most operators.

For example, United Airlines' aircraft has its A and C checks performed in-house by United Services, but it sub-contracts heavier checks to TIMCO. While the A320 fleet is due to increase by 50% over the next 10 years, some maintenance providers are increasing their capacity much sooner. Fehmi Kara, mechanical engineer at Turkish Technic, states that it completed 43 C checks in 2009, but aims to complete 65 in 2012: an increase of more than 50%.

The number of annual C and heavy checks generated by the fleet is about 3,000. Up to 750 of these will be heavy checks. The number of base checks will grow more or less in proportion with the fleet.

The intervals for the basic 1C tasks in the A320 MPD are now 6,000FH for system tasks, 4,500FC for structural items, and 20 months for zonal tasks. The four multiples of C check tasks are the 1C, 2C, 4C and 8C. The 4C and 8C tasks are heavier. These four multiples are arranged into a cycle of eight block checks: the C1, C2, C3, C4, C5, C6, C7 and C8 checks. The C4 and C8 are the heaviest, while the C1, C3, C5 and C7 are the lightest with just the 1C tasks.

C checks are performed in house by 24% of all A320 operators, with third-party facilities looking after the rest. Some of this 76% will in fact be carried out by airline maintenance & engineering departments. Examples are Air France Industries, Lufthansa Technik (LHT), United Services, Alitalia Servizi, Aveos Fleet Performance Inc (Air Canada) and British Airways Maintenance Glasgow (BAMG). Once these facilities, which maintain their parent airlines' aircraft, have been excluded, only 42% of the market is left to independent MRO providers. Within this group SR Technics does very well with just over 5% of the market, due in no small part to its easyJet contract. Gameco also does well with 4%, due to its location in China and Chinese contracts. Another Asia Pacific facility is STARCO, with nearly 4%. In North America the facilities with the highest market share of C check contracts are Aeroman (4%) and Empire Aero Center (nearly 3%), both of which have contracts with USAirways to take care of its C and heavy check requirements.

As both an MRO facility and an airline maintenance department, LHT has done especially well with 5.8% of the market, assisted by locations in Germany, Budapest, Malta and the Philippines.

Heavy checks

The fourth and eighth C checks (C4 and C8 checks) will be more intensive and include more tasks than a standard C check. This can mean a big spike in maintenance requirements, even more so for the C8 check. This has prompted MRO facilities, such as SRT, to equalise the workload and divide tasks in each multiple to create equalised checks. Other operators that do this in part or in full include Air China and Druk Air. Equalised workloads are often used for A



checks as well, so that an aircraft is not taken out of operation every five to six years for a large block check lasting for a number of weeks.

The 4C tasks, and C4 checks, have intervals of 24,000FH, 18,000FC and 80 months. The 8C tasks, and C8 checks have intervals of 48,000FH, 36,000FC and 160 months. The implications are that there is a heavy C check performed on an A320 once every 70-80 months, or about six years. Some operators have C4 check intervals shorter and longer than 80 months. This implies that the base check cycle of eight checks will be completed once every 11 to 12 years, an increase from about nine years when MPD intervals were shorter.

There are also two large groups of structural inspections, with intervals of 72 and 120 months. These consequently come due at similar times to the C4 and C8 checks, and the two types of check are combined by virtually all operators to form two heavy checks.

Most operators will sub-contract these checks to large maintenance providers. This is reflected in the market share of heavy check contracts, where just 19.5% of these checks are completed in-house. Nearly 53% of the heavy check market is available to independent providers. The independents are starting to do more work than the airline-linked facilities, with SRT, Gameco and STARCO achieving 5.13%, 4.72% and 4.61% shares. The airline-linked facilities of Air France Industries and Lufthansa Technik gained 4.29% and 4.08% shares. More than 7% is up for tender, including the heavy check contract for Delta Air Lines' A320 fleet.

While base-check intervals are 18 and 20 months, the actual intervals achieved

by airlines will be 16-17 months. On this basis, the global fleet will generate about 3,000 base checks each year. A quarter, about 750, will be heavy checks, leaving about 2,250 lighter C checks each year. Because the two heavy checks are the fourth and eighth checks in the cycle, the number of heavy checks will actually be fewer than 750 each year. The 1,500 or so aircraft delivered over the past four years have yet to generate any heavy checks.

Splitting this by global region, Europe is the largest market with about 1,650 aircraft. This fleet will generate about 1,200 base checks per year, and since the cost of ferrying the aircraft is generally prohibitive, most of these checks will be performed in Europe. This number is expected to grow by 50-100 checks per year, although there are also a large number of providers.

The second largest market is the Asia Pacific. With a fleet of more than 1,000 aircraft, it generates about 750 base checks per year. This number will also grow with future deliveries.

The number of C and heavy checks will increase in proportion with fleet growth. By 2020, with a projected fleet of 6,000 aircraft, the market will have grown to 4,000 base checks per year.

Landing gear

The interval for landing-gear overhaul on the A320 family is now 10 years or 20,000FC. Assuming an average interval of nine years, an average of up to 450 landing gears are being overhauled each year. The number may well be smaller, because of the nine-year lag between delivery and first gear overhaul.

Landing-gear overhaul is a specialist

Out of the 3,000 or so base checks required annually to serve the global fleet, about 1,200 are required for the European fleet of 1,650 aircraft. This number of checks is expected to grow by 50-100 per year in line with fleet expansion.

activity, so most operators sub-contract it. The most popular locations for landing-gear repair in North America are Messier Services-Mexico and Hawker Pacific Aerospace Ltd.

Within Europe some airlines are able to maintain their own landing gears, such as Air France Industries and Lufthansa Technik. Otherwise Hawker Pacific Aerospace Ltd is popular.

Several smaller providers include airline maintenance & engineering departments. Turkish Technic overhauled five landing gears in 2009 and they expect this number to almost triple to 13 in 2013, reflecting a larger THY fleet and also the increase by 50% of the global fleet generally over 10 years.

Thrust reversers

Thrust reversers are another specialist component. They not only have long removal intervals, but also require specialist tooling and equipment. The removal interval for CFM56-5B and V2500-A5 thrust reversers is 12,000-15,000FC. Most aircraft are accumulating 1,500-1,800FC per year. Given that each aircraft has two units, each aircraft has a reverser removed for overhaul on average once every seven or eight years. The global thrust reverser overhaul market is an annual volume of about 500-600 shipsets.

Turkish Technic forecasts that it will overhaul 33 thrust reversers in 2012. This is compared to 17 in 2009, which means it is following the global A320 family fleet and maintenance market growth.

The main providers of thrust reverser repair and overhaul are Middle River Aircraft Systems (MRAS), SNECMA, GEES, Nordam, Goodrich, Lufthansa Technik, Air France Industries, MTU Maintenance, Aveos Fleet Performance, Rolls-Royce, Aircelle, PWES, SR Technics, Iberia, and TAP Maintenance & Engineering.

Engine market

There are three engine options for the A320, although the PW6000 accounts for a small portion of the fleet. All PW6000s are young, so they are a long way from their first removals. The fleet is dominated by the CFM56-5A/-5B and the V2500-A1/-A5.

The CFM56-5A/-5B power about 2,400 of the 4,100 aircraft in operation. This fleet of 4,800 engines generates about 1,150 shop visits per year. This should grow to about 1,500 events per year by 2020.

The earliest A320s were powered by the CFM56-5A and V2500-A1. The later development of the larger and smaller A321 and A319, and the improved CFM56-5B and V2500-A5 has resulted in a mixed engine fleet for many airlines. British Airways, for example, has three engine types: the CFM56-5A1, CFM56-5B9 and V2522-A5.

CFM56-5A and -5B

The CFM56-5A and -5B-equipped aircraft make up the largest share of the fleet. The -5A powers 497 aircraft and the -5B powers 1,909: a total of 2,406 aircraft.

According to Lufthansa Technik, the CFM56-5A had an initial run of 19,000 engine flight hours (EFH), and a second and third run of about 8,000EFH.

The CFM56-5B, on the other hand, has a first run of 24,000-27,000EFH. Second and third planned removal intervals for most operators in temperate climates are 15,000-18,000EFH.

As would be expected, SNECMA and GE Engine Services (GEES) have the largest shares of engine overhaul contracts, with each accounting for about 21% of the market.

The global number of CFM56-5A shop visits is likely to remain stable at 360 engines per year. The CFM56-5B market, on the other hand, is likely to increase by nearly 20% over the next few years, with 800 CFM56-5B shop visits expected in 2010 and 950 in 2012. This means that by 2020, when the A320 family has doubled in size, the number of shop visits could have doubled to about 1,500.

Other major shops for the CFM56 are mainly airline-related. Lufthansa Technik and Air France Industries (including KLM Engineering & Maintenance) are the next biggest providers of this engine for the A320 family, with 10% and 9.5% shares of the market.

Air France Industries has two locations in Europe, while Lufthansa Technik has its main one in Europe and another in the Asia Pacific. The next largest airline-related shops are Aveos Fleet Performance in North America, and Alitalia Maintenance Systems in Europe, with 4% and 3.7% respectively.



Iberia and Delta TechOps each have a 2.5% share of CFM56-5A/-5B maintenance. While this does not seem a lot, they still both perform more than 100 engine shop visits per year.

Despite engine overhaul being a major undertaking, 7% of engine shop visits are still being completed in house by airline shops. TAP Maintenance & Engineering completes its own engine shop visits in house, with 16 expected in 2011 and 18 in 2014.

The independent MRO facilities, such as MTU Maintenance and SR Technics, are not currently major providers for the CFM56-5A and -5B models, with just 6.42% of the market between them. Although SR Technics has the maintenance contract for easyJet, one of the largest A320 family fleets, its engines are overhauled by GE Engine Services (GEES).

The majority of large engine shops offering CFM56-5A/-5B capability are located in Europe and North America, with third place going to the Asia Pacific. GEES is a good reflection of the location of the A320 family fleet, since it has two shops each in North America and Europe, one in South America and one in the Asia Pacific.

SNECMA also offers maintenance at various locations including North America, China, Europe and North Africa. Pratt & Whitney Engine Services (PWES) aims to increase its share as Turkish Technic transfers all its engine work to a joint venture that will operate through a new shop in Turkey.

V2500

There are 1,716 aircraft powered by the V2500 engine, the most popular

being the V2527 on the A319 and A320, of which there are 897 aircraft. With outstanding orders, this number will grow to at least 2,700 units by 2019.

The V2500-A5 is rated at between 22,000lbs thrust and 33,000lbs thrust. First removal intervals are 13,000-20,000EFH, depending on thrust rating. Mature intervals are 11,000-17,000EFH. The engines therefore tend to have shorter overall intervals than their CFM56-5B counterparts.

The annual shop-visit market for the V2500 is estimated to be about 850 shop visits, and this will increase with fleet growth. With current orders, the number of annual shop visits could rise to about 1,300.

While MTU Maintenance has a small share of the CFM56 market, its two facilities in Hannover and Zuhai combined have 33% of the contracts for the V2500. This is not surprising, given it is one of the original equipment manufacturers (OEMs) of the engine.

Other large providers include Lufthansa Technik, PWES, and Rolls-Royce. OEM IAE also has contracts for about 15% of the engines, and these will be sent to IAE's partner's shops.

Maintenance for this engine is well covered all over the world. There is a predominance of shops in Europe, the Asia Pacific and North America.

Other major shops include two operated as joint ventures by PWES, Evergreen Aviation Technical Corporation, Egyptair Maintenance & Engineering and SIA Engineering Company. [AC](#)

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