

There are more than 1,500 747-400s and 777s in operation, and they comprise the largest group of long-haul aircraft. They thus represent a large portion of the world's jetliner maintenance market. The types' major maintenance providers are considered.

# 747-400 & 777 support & maintenance market

**T**he 777 and 747-400 are the largest widebodies in operation, and together comprise the largest group of long-haul aircraft. More than 1,500 of these aircraft are in operation, with the 777 family accounting for most of the fleet.

The two types have to be considered together with their engines: the General Electric (GE) CF6-80C2; the Pratt and Whitney (PW) PW4000-94; and the Rolls Royce (RR) RB211-524G/H for the 747-400. There are three engine options from the same manufacturers for the 777: the GE90, PW4000-112 and RR Trent 800.

The 747's four-engined configuration means that it will generate more engine shop visits, so engine maintenance is a greater percentage of total maintenance costs on the 747 compared with the 777.

## Current fleet

There is a current fleet of 1,578 aircraft consisting of 895 777s and 683 747-400s. Just 67 aircraft are parked, so more than 95% of the fleet is active. A small number of parked aircraft indicates that neither type is close to being retired on a large scale in the near future. The 787 is aimed at different long-haul markets, and should not affect the 747-400 and 777 fleets.

The most common 747-400 model is the basic passenger model, accounting for 56% of the market, while one-third of the fleet are freighters. In all, there are 10 variants of the aircraft, with two being full passenger configurations and five being in freighter layouts. There are also combi and convertible variants.

The most common 777 models are the 777-200ER, followed by the 777-300ER, representing 46% and 28% of the fleet. The 777 freighter is relatively new, and there are only 37 777Fs in service. Passenger variants are generally too young to be considered for freighter conversion. There are a further three

models in operation, including the 777-200LR ultra-long-range variant.

The largest fleet geographically is in the Asia Pacific, where 719 of the fleet of 1,578 aircraft are found. Just under a quarter of the fleet (364 aircraft) is in Europe, and 18% is in North America.

Emirates has the largest 777 fleet, with 86 aircraft, followed by Singapore Airlines (66), Air France (57) and United Airlines (52), All Nippon Airlines (ANA) (49), British Airways (BA) (49), American Airlines (AA) (47), and Japan Airlines International (JAL) 46.

The largest 747-400 fleet is with BA which operates 57 examples. This is followed by Cathay Pacific Airways (46), Korean Air (42) and China Airlines (32). Lufthansa, QANTAS and United Airlines all operate 30 aircraft each.

Overall, this makes BA the largest operator of both types, with 106 aircraft. Emirates is the second largest operator, followed by United Airlines (82), and Cathay Pacific Airways (81).

There are 113 different operators. The percentage of aircraft owned by the operator is virtually the same for both aircraft, averaging at 61%. The aircraft have an average age of just over 10 years.

The 777 active fleet had average annual utilisation in 2010 of 4,253 flight hours (FH) 648 flight cycles (FC). The 777 fleet has an average FC of 6.56FH. The fleet has an average age of 7.2 years.

The 747-400 active fleet has a lower average annual utilisation of 4,105FH and 605FCs, but its average flight time is slightly longer at 6.7FH, while its average age is 14.1 years.

## Future fleet

There is a backlog of 268 aircraft on firm order, with another 296 order options, all for 777 family members. The 747-400 fleet will not grow in size, so it will slightly decrease over the years as the oldest examples are retired.

There are 66 outstanding deliveries of the 777-200, and 47 order options. Almost all have been ordered with GE90-110/115 engines, the largest order being from FedEx for 14 more freighter models.

American Airlines has a backlog of seven aircraft with Trent 800 engines (as well as an additional option for 34 aircraft). ANA has ordered an additional five -200s to add to its current 777 fleet, and these will replace some of its older 747-400s. Asiana has an order for two more PW4000-112-powered 777-200s.

The 777-300 has a large number of outstanding deliveries, totalling 202 aircraft. There are also 88 order options. All the aircraft will be equipped with GE90-110/115 engines. The largest order is with Emirates, for an additional 48 aircraft (on top of six -200 aircraft), and an order option for 39. Air China, Air France, Cathay Pacific Airways, Garuda Indonesia Airways, Saudi Arabian Airlines and Thai Airways International are all awaiting delivery of 10 or more aircraft over the next five years.

## Maintenance programme

The original maintenance planning document (MPD) for the 777 was issued in 1995, and the latest revision was released in September 2010. The latest revision to the 747's MPD was issued in November 2010.

Some operators have developed their own maintenance schedules. This can only be done with the approval of the local aviation authority and the OEM (see table, page 35). The 777 MPD makes this easier because there are no 'C check' packages. Each MPD item and task has its own unique interval. The operator then creates 'bucket' visits (similar to C checks) to complete groups of items.

The 747 MPD is traditional and follows a specific cycle of maintenance inspections and intervals. Fewer operators carry out an equalised

## 747-400 &amp; 777 FAMILY GLOBAL AIRCRAFT FLEET

Aircraft Variant	Engine Model	Africa		Asia Pacific		Europe		Middle East		N. America		S. America		Engine sub-total	Model sub-total
		Active	Parked	Active	Parked	Active	Parked	Active	Parked	Active	Parked	Active	Parked		
<b>747-400</b>															
747-400	CF6-80C2	2	1	58	6	51	1	8	1	1	11	4		144	387
	PW4000-94			66	2	14	2	11		41	6			142	
	RB211-524	1		37	3	53	7							101	
747-400BCF	CF6-80C2			1	3	2	1			6	1			14	42
	PW4000-94			19		2	2				1			24	
	RB211-524			4										4	
747-400BDSF	CF6-80C2			12										12	19
	PW4000-94			2		3				2				7	
747-400D	CF6-80C2			12	1						3			16	16
747-400ER	CF6-80C2			6										6	6
747-400ERF	CF6-80C2			8		16		2						26	40
	PW4000-94			14										14	
747-400F	CF6-80C2			35	1	9				25	4			74	124
	PW4000-94			30				2		1				33	
	RB211-524			6		11								17	
747-400LCF	PW4000-94									4				4	4
747-400PC	CF6-80C2			6		25	2	2		1				36	44
	PW4000-94			7				1						8	
747-400YAL-1A	CF6-80C2									1				1	1
747-400 total		3	1	323	16	186	15	24	3	82	26	4		683	683
<b>777</b>															
777-200	GE90-7/8/9	1		4		3								8	87
	PW4000-112			41		1	1			19	1			63	
	Trent 800			13				3						16	
777-200ER	GE90-7/8/9	3		27		78		27		22		4		161	414
	PW4000-112	8		40		3				33	2			86	
	Trent 800	4		72		24		12		55				167	
777-200F	GE90-110/115			9		9		4		13		2		37	37
777-200LR	GE90-110/115			10		1		18		16				45	45
777-300	PW4000-112			18										18	60
	Trent 800			30				12						42	
777-300ER	GE90-110/115	5		114	2	43		72		12		4		252	252
777 total		21		378	2	162	1	148		170	3	10		895	895
747-400/777 fleet		24	1	701	18	348	16	172	3	252	29	14		1,578	1,578

Source: Flight Global's ACAS system

maintenance programme on the 747-400 than on other aircraft types.

A relatively small airline will have a limited engineering department, so it will use a maintenance, repair & overhaul (MRO) facility that already has a maintenance programme for the relevant aircraft. This could be as simple as the standard MPD, or involve a smaller carrier following a larger operator's customised maintenance programme, to benefit from the lower maintenance costs.

## Check intervals

Line maintenance and A checks are generally undertaken by operators, but also by local suppliers or other airlines at outstations.

The intervals for A, C and D checks for a range of 747-400 and 777 operators are summarised (see table, page 35).

## Landing gear

Landing-gear overhaul is a specialist activity, with many facilities subcontracting it. An airline maintenance department or independent MRO facility, that offers a comprehensive list of capabilities, may also provide landing-gear services. AFI, JAL Engineering, LHT and Southern California Aviation repair landing gears for both aircraft types.

747-400 landing-gear overhaulers include Air India, Ameco Beijing, Bedek Aviation, El Al Israel Airlines, HAECO, QANTAS, South African Technical and ST Aerospace. For the 777, there is Alitalia, Gameco, TIMCO and United Services.

Some repair companies specialise in just a few jobs. As well as OEM support from Boeing Maintenance Services, specialists that offer landing-gear services on both aircraft types are AAR (with three shops), CIRCOR Aerospace, Goodrich (two shops), Hawker Pacific (two shops), Messier Services (two shops), Paramount Aircraft Services, Revima, Sargent Avborne, Stewart Industries Intl and TALSCO.

There are 36 facilities offering landing-gear capabilities for the 747-400. North America has 16, and South America has one, at TAP M&E Brazil. South African Technical has the only one in Africa. There are eight shops in Europe, and 10 in the the Asia Pacific.

There are 15 facilities in North America that offer landing-gear repair services for the 777, and nine in Europe. Just seven are in the Asia Pacific, despite the large 777 fleet there.

## Thrust reversers

Thrust reversers are another specialist

component. These have long removal intervals and require specialist tooling and equipment.

Most active 747-400s currently fly 4,100FH or 600FC per year. With four engines on the aircraft, and the thrust reverser having intervals of 5,000FCs, the aircraft is likely to have a reverser removed for overhaul once every two years.

The 777's two thrust reversers are maintained on an on-condition basis. Generally intervals of 6,000FC are seen on long-range 777s and intervals of 12,000-16,000FCs are seen on 777s used for short and medium-length routes. With an average annual utilisation of 4,200FH or 640FC, this aircraft is likely to have a reverser overhauled every five years.

As well as the OEMs, the main providers of thrust-reverser repair and overhaul for both aircraft types are: Applied Aerodynamics Inc in the US; and Goodrich (in the UK for the 747 and Asia for the 777). Goodrich's Singapore facility was the first to offer repairs to 777 Trent 800 thrust reversers, and has since carried out hundreds.

Those offering reverser repair for the 747-400 include: Korean Air, MRAS Asia Ltd, QANTAS, ST Aerospace Solutions and Triumph Airborne Structures. For the 777 an additional facility is Spirit Aerosystems (Europe). The AFI/KLM



E&M group offers a thrust-reverser shop, and says that it deals with an average of 80 CF6-80C2 and 20 GE90 reversers annually.

Delta TechOps, HAECO, M&E Brazil and TAP cater for thrust reversers for both aircraft types.

## Engine market

A number of airlines operate both the 777 and the 747-400, so mixed engine fleets are inevitable.

Engine maintenance involves a large investment in facilities, tools, equipment and training, so many operators and smaller MRO facilities do not have engine repair and overhaul capabilities. Older engines may, historically, still be maintained in-house, while newer engines are more likely to have a contract with the OEM.

Taking all engine options for both the 777 and 747-400, the shop that has the largest share of the market is GE Engine Services (GEES) Wales with 10%. There are a number of contracts with unknown shops, as well as a fair amount of in-house engine shops. These account for about 12% each of the joint fleet market. The next largest individual shops, with 4.8-5.8% of the market, are United Services, LHT, KLM E&M and AFI. The AFI/KLM E&M group accounts for more than 10% of the joint fleet's engine contracts.

LHT and its engine shop JVs have over 7.5% of the market. Of the OEMs, GE is the busiest, with nearly 16% of the market, because more than half the 777 fleet is powered by GE engines. RR and its many JVs account for 12% of the market, and PW deals with 7.5% of all 777/747-400 engine overhaul contracts.

### 747-400

There are three engine options for the 747-400: the CF6-80C2, the PW4000-94 and the RB211-524.

The market share of engine contracts undertaken in-house is nearly 16.5%, while unknown contracts account for 13%. Contracts up for tender make up 2% of the market. LHT seems to have the most 747-400 engine customers, accounting for 9.5% of the market. When its JVs, Ameco Beijing and LTQ, are combined, it deals with nearly 13% of the 747-400 market.

KLM E&M is the next busiest individual engine shop with over 7.5% of the market. This means that the AFI/KLM E&M group, as a whole, has nearly 12% of the 747-400 market, which amounts to 110 annual shop visits.

When all the engines for the 747-400 are considered together, the OEMs do not have such a monopoly, with each one gaining no more than 8.5% of the total market.

### CF6-80C2

As expected, GEES is the largest CF6-80C2 maintenance provider. The three GE locations (two in the US and one in Scotland), account for a quarter of all CF6-80C2 maintenance. GE Caledonian undertakes 16% alone, for customers like Air Atlanta Icelandic, Eva Air, Kuwait Airways, Saudi Arabian Airlines and UPS.

The second busiest individual facility is LHT, with nearly 9.5% of the market. Customers include Aerolineas Argentinas, Asiana Airways, South African Airways and Jade Cargo International. Add this to its JV with QANTAS (LTQ Maintenance), and LHT deals with nearly 12% of the market. Nearly 9% of engine

*The variation in the 777's airframe maintenance programmes makes it harder to quantify the market size for heavy maintenance visits for the type. There are almost 900 777s in operation, and another 268 on order. The 777 is the most numerous of the largest widebodies in operation.*

overhauls are still undertaken in-house.

The KLM E&M group has a 9.5% share. Other important engine shops are: ANA Engine Services, Evergreen Aviation Tech Corp (EGAT), JAL Engineering and MTU Maintenance Hannover.

### PW4000-94

This PW engine accounts for 34% of the 747-400 fleet (232 aircraft), but is also available for other aircraft like the 767. Again, this might be popular with operators that have a mixed fleet. It also means that the choice of engine shops should be good, as seen with the CF6.

As with the CF6-80C2, the OEM is the main overhauler with PW's Cheshire Engine Center taking over a fifth of the PW4000-94 market. Customers include Delta Air Lines, El Al Israel Airlines and Evergreen International. PW's Asia operation, Eagle Services Asia, also accounts for well over a tenth of the market, so PW oversees 34% in total.

Compared to the CF6-80C2, a higher percentage of PW4000-94s are dealt with in-house, with 13% of shop visits carried out by airline M&E departments. The largest non-OEM share is with LHT, which deals with 14% of the market. Its customers include Corsairfly and Cathay Pacific Airways. This is followed by United Services with 10.5%. Delta TechOps is also a large player, followed by Ameco Beijing, GEES Malaysia and SR Technics. The latter undertakes 20 shop visits, on average, annually.

### RB211-524

The third engine option for the 747-400 is the Rolls-Royce RB211-524G/H, which powers 122 aircraft.

There are a limited number of engine shops for these engines, with a fifth of work completed in-house and nearly half of contracts unknown. Hong Kong Aero Engine Services Ltd (HAESL) is the largest single engine shop, accounting for nearly 18% of the market. HAESL is an RR JV, so RR itself oversees nearly a quarter of the market. There are about 49 RB211-524 shop visits completed annually by the HAECO Group, which includes HAESL.

### 777

There are again three engine types for the 777, offered by the same three OEMs

## 747-400 &amp; 777 FAMILY AIRFRAME &amp; COMPONENT MAINTENANCE - MAJOR PROVIDERS

Maintenance facility	Aircraft Capability		A Check	C Check	Composites	Heavy Check	Strip/Paint	Interiors/Furnishings	Landing Gear	Wheels/Tyres/Brakes
	747-400	777								
<b>Africa</b>										
South African Technical	Y		Y	Y	Y	Y	Y	Y	Y	Y
<b>Asia Pacific</b>										
Air India	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jet Airways (India)		Y	Y	Y	Y	Y	Y	Y	Y	Y
Ameco Beijing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
ANA Aircraft Maintenance	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
ANZES	Y		Y	Y	Y	Y	Y	Y		Y
Asiana Airlines	Y	Y	Y	Y	Y	Y	Y	Y		Y
Bedek Aviation (Divn of IAI)	Y		Y	Y	Y	Y	Y	Y	Y	Y
China Aircraft Services (CASL)	Y	Y	Y	Y	Y	Y	Y	Y		Y
Evergreen Aviation Tech Corp.	Y	Y	Y	Y	Y	Y	Y	Y		Y
Gameco	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GMF AeroAsia	Y		Y	Y	Y	Y	Y	Y		Y
HAECO	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hypercoat	Y	Y	Y	Y	Y	Y	Y	Y		Y
JAL Engineering	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
John Holland Aviation Services	Y		Y	Y	Y	Y	Y	Y		Y
Korean Air	Y	Y	Y	Y	Y	Y	Y	Y		Y
Lufthansa Technik (Philippines)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Malaysia Airlines	Y	Y	Y	Y	Y	Y	Y	Y		Y
PeKAMCO	Y	Y	Y	Y	Y	Y	Y	Y		Y
PIAC		Y	Y	Y	Y	Y	Y	Y		Y
PKMRO		Y	Y	Y	Y	Y	Y	Y		Y
QANTAS	Y		Y	Y	Y	Y	Y	Y	Y	Y
Sepang Aircraft Engineering	Y	Y	Y	Y	Y	Y	Y	Y		Y
SIA Engineering Company Ltd	Y	Y	Y	Y	Y	Y	Y	Y		Y
ST Aerospace Services Co. Pty	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
STARCO	Y		Y	Y	Y	Y	Y	Y		Y
TAECO	Y	Y	Y	Y	Y	Y	Y	Y		Y
Thai Airways International	Y	Y	Y	Y	Y	Y	Y	Y		Y
Vietnam Airlines Eng Co. -VAECO		Y	Y	Y			Y			
<b>Europe</b>										
Air France Industries	Y		Y	Y	Y	Y	Y	Y	Y	Y
Alitalia		Y	Y	Y	Y	Y	Y	Y	Y	Y
APPH Basingstoke MRO	Y								Y	Y
Beagle Aerospace	Y				Y		Y			Y
British Airways Engineering & BAMC	Y	Y	Y	Y	Y	Y		Y		Y
Cargolux Airlines	Y		Y	Y	Y		Y			Y
Haltec	Y		Y	Y						Y
Jet Aviation Basel	Y		Y	Y	Y	Y	Y	Y		Y
KLM Engineering & Maintenance	Y	Y	Y	Y	Y	Y	Y	Y		Y
Lufthansa Technik	Y	Y	Y	Y	Y	Y	Y	Y		Y
Lufthansa Technik Maintenance Intl.	Y	Y	Y	Y	Y	Y	Y	Y		Y
Marshall Aerospace	Y	Y	Y	Y	Y	Y	Y	Y		Y
Nayak Aircraft Service Italy		Y	Y	Y	Y		Y			
Polar Air Cargo - Prestwick	Y		Y	Y	Y		Y			
SR Technics	Y	Y	Y	Y	Y		Y	Y		
TAP Maintenance & Engineering		Y	Y	Y	Y	Y	Y			
Turkish Technic	Y		Y	Y	Y		Y			
X-air Services	Y		Y	Y	Y	Y	Y			
<b>Middle East</b>										
Abu Dhabi Aircraft Technologies	Y	Y	Y	Y	Y		Y	Y		Y
Alsalam Aircraft Company	Y		Y	Y	Y	Y	Y	Y		Y
El Al Israel Airlines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Emirates		Y	Y	Y	Y	Y	Y	Y		Y
Farsco	Y		Y	Y	Y	Y	Y			
Goodrich Cust. Svcs - Dubai	Y		Y	Y	Y	Y	Y	Y		
Kuwait Airways	Y	Y	Y	Y	Y	Y	Y			
Saudi Arabian Airlines	Y	Y	Y	Y	Y		Y			
<b>North America</b>										
AAR Landing Gear Services		Y							Y	
Aeromexico		Y	Y				Y			
Aircraft Systems		Y							Y	
Allflight	Y	Y			Y		Y	Y		
Aloha tech Ops	Y	Y	Y		Y		Y			
American Airlines		Y	Y	Y	Y	Y	Y	Y		Y
Associated Air Center	Y		Y	Y	Y	Y	Y	Y		
Aveos Fleet Performance Inc.		Y	Y	Y	Y	Y	Y	Y		Y
Aviation Technical Services	Y	Y	Y	Y	Y	Y	Y			Y
Boeing Maintenance Services	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Circor Aerospace		Y							Y	
Certified Aviation Services	Y		Y	Y	Y	Y	Y			Y
Delta TechOps	Y	Y	Y	Y	Y	Y	Y	Y		Y
Evergreen Air Center	Y	Y	Y	Y	Y	Y	Y	Y		Y
Global Aerospace Corporation		Y							Y	
Goodrich		Y			Y				Y	
Great Southwest Aviation	Y		Y	Y	Y	Y	Y			
Hawker Pacific Inc. USA	Y	Y							Y	Y
Kalitta Air	Y		Y	Y		Y				
L-3 Comms A/C Integration Sys	Y		Y	Y	Y	Y	Y	Y		Y
Lufthansa Technik Component	Y	Y	Y	Y	Y				Y	Y
Pacific Aerospace Res & Tech	Y	Y	Y	Y	Y		Y			
Premier Av OvH Center (Rome)	Y		Y	Y	Y	Y	Y			
Sargent Avborne	Y	Y						Y	Y	Y
Southern California Aviation	Y	Y	Y	Y			Y	Y	Y	
ST Aerospace Mobile Inc	Y	Y	Y	Y	Y	Y	Y			
ST Aerospace san Antonio	Y		Y	Y	Y	Y	Y	Y	Y	Y
Stambaugh Aviation (Brunswick)	Y		Y	Y	Y	Y	Y			
Stewart Industries Intl.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
TIMCO (Greensboro)		Y	Y	Y	Y	Y	Y	Y	Y	Y
United Services	Y	Y	Y	Y	Y				Y	Y
<b>South America</b>										
Aerolineas Argentinas	Y		Y	Y	Y	Y	Y			
Aerosur	Y		Y	Y		Y				
TAM Lineas Aereas		Y	Y	Y		Y				
TAP M&E Brazil (Rio)	Y	Y	Y	Y	Y	Y	Y	Y		Y

Source: Flight Global's ACAS system

## 747-400 &amp; 777 MAINTENANCE INTERVALS

	A Checks				C Checks				D Checks				
	FH	FC	Days	Months	FH	FC	Days	Months	FH	FC	Days	Months	
<b>747-400</b>													
MPD	1,000				10,000			24				96/72	
Popular interval range	500-1,000	150	50-91		6,000-10,000			18-24		25,000-		72-96	
Air Pacific	2,000 (8 phases repeated every 2,000FHs)				6,200					30,000			
British Airways	600(2A at 99 days & 4A at 190 days)				(2C at 36 months)				18	(1st 'Major ck' at 8 yrs)			72
Delta TechOps	700				9,600			24	28,000			72	
KLM Royal Dutch Airlines	850	150						24	60mths/25,000FHs if a/c over 18yrs)			72	
Korean Air	1,000			2	10,000			24				72	
Kuwait Airways	500		91	(Low utilisation a/c)	5,000			36				108	
Japan Airlines Intl.	600				7,500			18				72	
	(C checks can also be at 3,500FH or 18 months & D checks at 66 months when on domestic services)												
United Airlines	500						547	18			2,189		
UPS	420		77					18				96	
	(A checks are in 8 segments, repeated until all segments of a C check are completed, then the whole process is repeated)												
<b>777</b>													
Popular interval range	500-1,500	100-250	60-100		6,000-12,000	960-4,000	500-1,125	18-36	16,000-30,000	16,000	1,500-3,000	96	
Alitalia	1,000		75		12,000		750				3,000		
	(12 equally weighted phases make up an A check)												
All Nippon Airways	500					4,000	750		(A/C on domestic operations have a mid-C check at 2,000FHs)				
British Airways	500				12,000	4,000	750		48,000	16,000	3,000		
EL AL Israel Airlines	600 (A check comprises 12 checks)				7,500			24					
Japan Airlines International	750				7,500				16,000		3,000		
United Airlines	500						456				3,287		

Source: ACAS and direct from airlines

as on the 747-400. There is the PW4000-112, Trent 800 and the GE90, the latter being the most popular. This is in part due to it being the only engine option on recent 777 derivatives.

Just 6.6% of engines are dealt with in-house on the 777, compared to more than double that figure on the 747-400. GEES Wales is the busiest shop, with 24% of the 777 engine contract market.

This is followed by RR's JV, SAESL, with just over 10%. GE's overall share, taking in two shops, is over a quarter of the market. RR has, including JVs, four shops globally and undertakes just under a quarter of shop visit contracts. This share is high due to the control it has over all Trent 800 maintenance.

PW's total 777 share is low, at just over 5.5%. AFI is another shop with a large share of the market and, adding in KLM E&M's share, this means the group deals with just over 11.5%. As well as Air France and KLM, it also overhauls engines and components for Air Canada, China Cargo Airlines, Air Austral and Vietnam Airlines. On average it carries out 50 shop visits annually for the 777.

The HAECO Group, which includes HAESL, undertakes 17 engine shop visits annually, specifically on the GE90 and Trent 800.

There are not as many shops for 777 engines as for the 747-400, with OEMs having a lot more control.

### GE90

The GE offering for the 777 is by far the most popular, with 56% of the fleet

equipped with GE engines. This is due in part to later 777 models only being available with GE engines.

Again, GE is the maintenance provider with nearly half the market. GE has two shops, the main one being in Wales, where 42.5% of all GE90 contracts are dealt with. This facility was once part of BA, and it is still the engine shop for all BA GE90s, as well as for those of Delta Air Lines, Emirates, Eva Air, Singapore Airlines, Cathay Pacific Airways, Etihad Airways, Austrian Airways, Saudi Arabian Airlines and Continental Airlines.

Just 10.5% of engines are overhauled in-house by airlines. AFI is the largest non-OEM shop for the GE90, with 16% of the market. Its partner KLM E&M's shop deals with an additional 4%.

### PW4000-112

The PW4000-112 is the third PW4000 derivative and is often, but not necessarily always, overhauled by the same shops as the PW4000-94. For the 777 fleet, this engine accounts for just 19% (167 aircraft).

The largest shop, in terms of share of the market, is United Services with 35%. As well as United Airlines, this shop does work for Air China and Korean Air. The OEM's Cheshire Engine Center is pushed into second place with 25% of contracts (with a number of Asia Pacific airlines). ANA Engine Services deals with 18% of the market, due in no small part to the fact that ANA operates 30 777s equipped with PW engines.

JAL Engineering's engine shop also deals with a number of PW engines.

### Trent 800

The second engine choice for the 777 is the RR Trent 800, which is only available on 777 aircraft. It accounts for a quarter of the fleet or 225 aircraft, but gains 41% of the market for the 777 variants it powers (it is not an option for the 777-200LR or 300ER).

It seems that RR has absolute control of most of the maintenance on this engine. The main engine shop is SAESL in Singapore with over 40% of the market. Customers include Thai Airways International, Emirates, Singapore Airlines and Malaysia Airlines.

This is followed by TAESL in the US (with customers including AA) with nearly 21%.

RR's Aero Repair & Overhaul facility in the UK undertakes nearly 16.5% of the market with customers including Kenya Airways, Air New Zealand El Al Israel Airlines and British Airways.

HAESL's customers include Emirates, Malaysia Airlines and Cathay Pacific Airways and deals with just over 10.5%.

With all these engine shops being either a fully-owned RR shop or RR JV, RR oversees at least 88% of the market. Just 3% are dealt with in-house and 8% of contracts are unknown.

### Additional services

A potential development is maintenance management of a customer's

## 747-400/777 FAMILY ENGINE AND ENGINE COMPONENT MAINTENANCE - MAJOR SHOPS

Maintenance facility	CF6 -80C2	PW4000 -94	RB211 -524	GE90	PW4000 -112	Trent 800	Engine Overhaul	H.S.I.	Acc. drive gearbox	Electrical system	Fuel system	LRU	Lubrication system	Thrust reverser
AAR Component Svs - NY	Y	Y		Y	Y				Y	Y	Y	Y	Y	Y
Abu Dhabi Aircraft Technologies	Y		Y				Y	Y	Y	Y	Y	Y	Y	Y
Accel Aviation Accessories	Y	Y			Y				Y	Y	Y	Y	Y	
AEM Ltd	Y		Y						Y	Y	Y	Y	Y	
Aeromexico		Y					Y	Y	Y	Y	Y	Y	Y	
Air France Industries	Y			Y			Y	Y	Y	Y	Y	Y	Y	Y
Air India	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
Air Austral				Y			Y	Y						
Aircraft Ducting Repair		Y			Y					Y			Y	Y
Alitalia	Y								Y	Y	Y	Y	Y	Y
Alitalia Maintenance Systems	Y						Y	Y	Y	Y	Y	Y	Y	Y
Ameco Beijing		Y					Y	Y	Y	Y	Y	Y	Y	Y
American Airlines	Y					Y	Y	Y	Y	Y	Y	Y	Y	Y
AMES	Y			Y								Y		Y
ANA Engine Services Co. Ltd	Y	Y			Y		Y	Y						
ANZES	Y		Y				Y	Y	Y	Y	Y	Y	Y	Y
Auxitrol S.A.	Y		Y	Y		Y				Y		Y		
Bede Aviation (Divn of IAI)		Y					Y	Y						
China Airlines		Y					Y	Y						
Chromalloy Dallas	Y		Y		Y						Y	Y	Y	
Chromalloy Holland	Y	Y			Y						Y	Y	Y	
Complete Turbine Service	Y	Y	Y		Y		Y	Y						
CRMA	Y			Y			Y	Y		Y		Y		
Delta TechOps	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
Eagle Services Asia Pte Ltd		Y			Y		Y	Y	Y	Y	Y	Y	Y	Y
Eaton Aerospace		Y			Y		Y	Y			Y	Y		
EgyptAir Maint & Engineering		Y			Y		Y	Y						
Evergreen Aviation Tech Corp	Y						Y	Y						Y
Finnair	Y						Y	Y	Y	Y	Y	Y	Y	Y
Fokker Aerotron		Y	Y		Y				Y	Y	Y	Y	Y	Y
Gameco	Y		Y	Y				Y	Y	Y	Y	Y	Y	Y
GE Caledonian Ltd	Y						Y	Y	Y	Y	Y	Y	Y	
GE Celma Engine Services	Y						Y	Y	Y	Y	Y	Y	Y	Y
GE Engine Services - Japan	Y						Y	Y	Y	Y	Y	Y	Y	Y
GE Engine Services - Malaysia		Y					Y	Y	Y	Y	Y	Y	Y	Y
GE Engine Services - Wales			Y	Y			Y	Y	Y	Y	Y	Y	Y	Y
Goodrich Cust. Svcs - Dubai						Y						Y		Y
HAECO			Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
HAESL			Y			Y	Y	Y	Y	Y		Y	Y	Y
IHI Corporation	Y			Y			Y	Y			Y			
JAL Engineering	Y			Y	Y		Y	Y						
Jet Aviation Dubai		Y			Y		Y	Y						
Jet Technology Center Ltd	Y						Y	Y	Y	Y	Y		Y	
Jordan Airmotive	Y	Y					Y	Y						
KLM Engineering & Maintenance	Y			Y			Y	Y	Y	Y	Y	Y	Y	
Korean Air		Y					Y	Y	Y	Y	Y	Y	Y	Y
LITQ Maintenance	Y						Y	Y						
Lufthansa Tech Composite Tulsa	Y											Y		Y
Lufthansa Technik	Y	Y					Y	Y	Y	Y	Y	Y	Y	Y
Lufthansa Technik (Shenzhen)	Y							Y	Y	Y	Y	Y	Y	Y
Lufthansa Technik Intercoat	Y	Y	Y	Y	Y					Y	Y	Y	Y	Y
Meggitt Aircraft Braking Sys			Y			Y				Y			Y	
Mitsubishi Heavy Industries		Y			Y		Y	Y	Y	Y	Y	Y	Y	Y
MTU Maintenance Hannover	Y			Y			Y	Y	Y	Y	Y	Y	Y	Y
P&W Cheshire Engine Center		Y			Y		Y	Y	Y	Y	Y	Y	Y	Y
Patriot Aviation Services		Y	Y		Y		Y	Y						
PIAC	Y						Y	Y	Y	Y	Y	Y	Y	Y
PKMRO	Y						Y	Y						
PWA International		Y			Y		Y	Y						
QANTAS	Y		Y				Y	Y	Y	Y	Y	Y	Y	Y
Rolls-Royce Aero Repair & O/hl			Y			Y	Y	Y	Y	Y	Y	Y	Y	Y
SAESL					Y		Y	Y						
SIA Engineering Company Ltd				Y			Y	Y						
SNECMA (MRO Division)	Y			Y			Y	Y	Y	Y	Y	Y	Y	Y
SR Technics		Y					Y	Y	Y	Y	Y	Y	Y	Y
ST Aerospace	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y
TAESL					Y		Y	Y	Y	Y	Y	Y	Y	Y
TAP Maintenance & Engineering	Y		Y				Y	Y	Y	Y	Y	Y	Y	Y
TCI	Y	Y			Y		Y	Y			Y	Y		
TEXL				Y			Y	Y						
Thai Airways International	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
Triumph Acc. Svcs. Grand Prairie		Y	Y	Y	Y	Y			Y	Y	Y	Y		
Turkish Technic	Y						Y	Y						
Twin Manufacturing	Y	Y			Y				Y		Y	Y		
United Services		Y			Y		Y	Y	Y	Y	Y	Y	Y	Y
Woodward Governor Co.	Y	Y			Y						Y	Y		

Source: Flight Global's ACAS system and direct from airlines

whole fleet. Delta TechOps, AFI and LHT are examples of MROs that offer this service, with the addition of maintenance programme management.

Generally most MRO facilities will offer an aircraft-on-ground (AOG) service. SR Technics, for example, offers AOG for specific part numbers on a 24/7 basis with a global field-team for line maintenance activities.

Some larger facilities, such as LHT and Delta TechOps, will have a spare engine service, where customer airlines are able to 'borrow' engines while theirs

are being overhauled. Goodrich does not have spare engine support, but it does offer a service in nacelle rotatables and flight control surfaces for customers, with stock worth over \$600 million.

Delta TechOps is one of many which offers component exchange and rotatable support packages. HAECO also offers a component service with its Inventory Technical Management package. This includes component pooling, AOG management, logistics and technical services, right up to modification level.

Engines will always need to be

monitored to see when they are losing performance and need to be overhauled or repaired in some way. An engine monitoring service is again one of the many additional services offered by large MRO companies. SR Technics offers this as a full engineering and data trend monitoring service for the PW4000-94, alongside piece-part repair of most -94 engine parts. [AC](#)

To download 100s of articles like this, visit:  
[www.aircraft-commerce.com](http://www.aircraft-commerce.com)