

5-11 November 2002

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FLIGHT

INTERNATIONAL

World airliners: part 1

Heavy metal

We chart progress of every large jet programme



Boeing
eyes 777
stretch

Sita puts
airports in
a box



The longest trail



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FiatAvio

power to the Future

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FiatAvio will be present at the Zhuhai Airshow, Hall 1, Stand 1C2/2-4

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World airlines: part 1

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Boeing eyes 777 stretch

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ETIENNE DE MALGOUVE

COVER STORY

Commercial aircraft 37

With Airbus making smooth progress in development of its giant A380 airliner – assembly is due to start in 2004 – US rival Boeing finds itself at a crossroads with its product-development strategy. Does the manufacturer proceed with the advanced technology behind its Sonic Cruiser? Or should it heed the advice of airlines and instead concentrate on making its next-generation aircraft cheaper to fly, rather than faster, in which case its all-new 250-seater "Project Yellowstone" may fit the bill. Part one of our directory provides news of these programmes, plus histories and full technical specifications of every aircraft in production with more than 100 seats.

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A computerised information system is transforming operations at airports in Mexico and is set to do the same at terminals elsewhere in the Americas. The ability of Sita's airport operations IT system, Airport-in-a-Box, to allow real-time flight information to be displayed at monitors throughout airport terminals is a boon to passengers, but the system also improves airport efficiency. Plus, how Lockheed Martin is entering a new arena – information management systems for airlines and airports that offer, among other things, a product suite with real-time tools to help in the handling of irregular operations, analysis tools and integration of air and ground surveillance data.



Next week

Commercial aircraft

Part 2 of our directory focuses on regional aircraft, with programme updates on every aircraft with 100 seats or fewer on the market, from the Airbus A318 and Boeing 737-600 to the B-N Islander. We also report from the Chinese air show in Zhuhai.

A photograph showing the interior of an aircraft cockpit at night. Two pilots in white uniforms are visible from behind, looking out at a runway illuminated by lights. The cockpit is filled with various instruments, dials, and control panels.

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ATI Air Transport Intelligence (ATI), *Flight International's* sister online service at www.rati.com, contains the full text of *Flight International* and *Airline Business* since 1996. Full text of the magazines can also be found online with Lexis-Nexis, Dialog, FT Profile, IAC and Reuters. Editor Kieran Daly +44 (20) 8652 3837

 Reed Business Information

Hard lessons

Modern defence procurement is complicated, with the need to acquire a capability not just a platform, but is proving more difficult than expected

When in 1995 the British Army selected the Boeing AH-64D Apache Longbow to meet its attack helicopter need, it was clear that the service would be achieving a massive step forward in capability. But it was equally obvious that the army was faced with an equally giant task of ensuring that the Army Air Corps got its Westland-built Apache AH1s on time, on budget and in a way that provided a meaningful operational capability.

"Realising the undoubted complexity of the task, the UK Ministry of Defence, the army and others took a six-pronged approach to acquire a capability, not just a programme. This in itself was a step forward in defence procurement, a shift from the seemingly traditional "let's get the shiny new toys and worry how to use them later" approach. The six lines adopted were: delivery of equipment; development of force structures and infrastructure; development of concepts and doctrine; training; recruitment and

predicted to save the taxpayer £23 million (\$36 million). Unfortunately, the contract signed by the MoD means it has paid £34 million for courses not taken because training material was not available from Westland as prime contractor. Other training problems have incurred a £6 million cost to pay for storing around half of the Apaches after delivery.

From the evidence in the NAO report, the MoD has taken a best-practice approach to the Apache, and it should be given a pat on the back for concentrating on acquiring the capability and not just the platform. However, the ministry does seem to have ignored commonsense in a number of areas.

Perhaps the most shocking slip was a £120 million spares package contract awarded to Westland to support the first 30 months of flying. That two-and-a-half year period ended on 31 October – last week – and unfortunately, because training is delayed and the number of flying hours about two-thirds fewer than planned, around 67% of the spares spend has gone to waste. The situation is exacerbated by a failure to agree the follow-on contract and the British Army could be faced with key spares shortages, particularly of long lead items. The NAO recommends in its report that more risk should have been transferred to the contractor by linking payments to measures of actual activity, such as flying hours.

Having learned some tough lessons on the Apache contract, the MoD should now set out to make sure that it learns from its mistakes and does not repeat them on future contracts. The ministry should create a team or organisation or invest in some software package that will drive home to all those involved in spending the taxpayers' money how to use the funds wisely. Not only should it learn from the NAO's latest report, but also from best practice it has established elsewhere in the procurement chain. For instance, "linking payments to measures of actual activity" is a standard way of paying for PFI services, so why not in the case of the Apache contractor spares package? However, on a cautionary note, the armed forces and those around them have a tendency to perform procedures "by numbers" rather than applying the right processes to suitable problems. This is as harmful as not learning important lessons.

The MoD can take some heart from the NAO's report. The ministry has used initiative and escaped from outdated methods of doing business, but now it must ensure that some hard lessons are not wasted.

SEE DEFENCE P20

The good news is that the NAO found positive aspects to the programme

retention of manpower; and supporting and sustaining the Apache in service.

Last week the UK's National Audit Office (NAO) released a report on progress. The good news is that the NAO, not known for giving the MoD an easy ride, found positive aspects to the programme. Deliveries are a little late, but four months is nothing to worry about, while overspend is a miserly 2.5%. The force structure and infrastructure will be in place when needed, and manpower issues appear minor. However, the training programme is way behind schedule – it should have started in September last year but is running two years late. There are issues with the military aircraft release, acquisition of defensive aids test equipment, and the support system is not fully defined.

Some of the problems are a result of removing acquisition of the weapons and training packages from the prime contract and making them separate awards. It was intended to compete the supply of pilot and groundcrew tuition, but it was then decided to award the contract without competition to a Boeing/Westland joint venture Aviation Training International (ATI). The 30-year private finance initiative (PFI)-funded deal was

AIR TRANSPORT GUY NORRIS / LOS ANGELES

Boeing reveals 777-250ERX study

Potential third variant emerges as PIA ends -200LR/300ER sales drought with order for five aircraft

Boeing is evaluating a possible third member of its ultra-long-range 777 family in response to airline interest in a new extended-range twinjet with a similar range to the 777-300ER, but with more capacity than the 777-200LR.

Boeing says the product development study for the 777 variant is "one of many". The study, dubbed the 777-250ERX, is understood to be looking at a nine- or 10-frame stretch of the General Electric GE90-110B-powered -200LR, making it about 68.6m (225ft) long overall, against almost 74m for the GE90-115B-powered -300ER, and 63.7m for the -200LR. The stretch would provide roughly 10% more passenger capacity than that of the baseline aircraft, although it would trade range for payload. The aircraft is expected to be offered with

capacity for up to 320-330 passengers over maximum ranges of around 13,900km (7,500nm).

First details of the study proposal come as Boeing finally breaks the 50 firm-order barrier for the GE90-powered derivative family after a two-year sales drought. Pakistan International (PIA) has ordered two -200LRs and three -300ERs as part of an eight-strong \$1.4 billion 777 order that includes three -200ERs. Deliveries are due between February 2004 and 2008. No engine selection has been confirmed for the three -200ERs, but PIA said before it placed the order that GE90s would power the aircraft.

PIA's two -200LRs are the first new orders for the variant since July 2000, when EVA Air of Taiwan launched it with an order for three.

The PIA order takes -200LR/300ER family orders to 54, and total 777 orders to 607.

Regardless of whether the -250ERX becomes a real programme, the manufacturer says a revised development schedule for the delayed -200LR will be decided in the second quarter of next year. The first EVA 777-200LR was originally scheduled for delivery in January 2004, but the effort was put on ice in September 2001.

GE has, meanwhile, been forced to delay certification of the GE90-115B engine for the new derivatives following the discovery of a problem on one of the endurance engines. GE engineers found evidence of "distress" on the first-stage high-pressure turbine blade platforms in the 150h block test engine performing the "triple red line"

endurance testing. "The base of the blade was showing some slight distortion," says GE, which is correcting the problem by routing more cooling air to the zone.

"The bottom line is that we have to stop the test to validate it," says GE, which had originally planned to complete engine certification in December. The GE90-115B block test engine, one of seven currently running in the programme, had reached 35h when the issues were discovered. More crucial large bird-strike and fan blade-off tests are due to take place over the next month.

The delay means tests will run through to the end of the year and certification may slip to late January or February. Boeing plans to start 777-300ER flight tests in early January as planned, assuming no more issues emerge.

DEFENCE PAUL LEWIS / WHITEMAN AFB, MISSOURI

USAF plans first overseas B-2 base

The US Air Force is for the first time planning to operationally deploy the Northrop Grumman B-2 bomber overseas. The aircraft will operate from bases in the Indian Ocean and the UK to spearhead US airstrikes against Iraq, if necessary.

The move follows the delivery of specially designed climactically controlled transportable shelters that are necessary to support the low observable (LO) aircraft at forward operating locations.

"We're going to forward deploy this aircraft; that is our charter," says Col Doug Raaberg, commander of the USAF 509th Bomb Wing. The move will enable the air force "to cycle the aircraft as rapidly as necessary, with faster turnaround, and put more bombs on target", he says. Two principal locations are being eyed to position the B-2 closer to Iraq - RAF Fairford and the UK-administered island of Diego Garcia in the Indian Ocean.

To support the deployment, the USAF has ordered five aluminium-truss transportable hangars at a cost of \$2.5 million each. The last is in the final stage of delivery, says manufacturer American Spaceframes Fabricators. The 76m (250ft)-wide, 38m-long shelters are covered by two polyester vinyl layers and are climactically controlled using three 65,000kg (143,000lb) air conditioners, strip heating and a 190litre/h (50USgal/h) capacity humidifier.

"This is not a shelter for bad weather; they are environmentally controlled conditions for aircraft skin treatment," says Raaberg. The B-2 uses a substantial amount of filler and masking to seal access panels and hatches to reduce the aircraft's radar signature, which must be inspected for defects after each mission. While new LO technology such as the spray-on advanced high-frequency material



The B-2 will operate from bases in the Indian Ocean and the UK

promises to reduce maintenance time substantially, like paint it still requires around a 20°C (69°F) temperature and 30-60% humidity to cure.

As a result the B-2s used during the Afghanistan and Kosovo conflicts were operated from their home base at Whiteman AFB, Missouri, which features 14 purpose-built bays and two dedicated LO docks. Whereas the USAF's Boeing B-52s and Rockwell B-1Bs flew from Diego Garcia, the B-2 always returned to the USA after a crew change on the island - a round trip of 70h. Of around 7,000

USAF combat missions flown in the first 120 days of the Afghan war, the B-2 accounted for just 12, whereas the 40-year-old B-52 flew 584 sorties.

The majority of the shelters are earmarked for Diego Garcia, which, unlike Anderson AFB on Guam, has no modified facilities to support the B-2. At least one shelter will be erected at RAF Fairford to supplement existing facilities now being improved. The USAF is planning a simulated overseas basing exercise, which it estimates would generate 50 sorties for every four home-based missions.

DEFENCE GRAHAM WARWICK / WASHINGTON DC

US Navy awaits F-5 acquisition approval

Meanwhile F-16A/Bs are delivered for air-combat training

The US Navy is awaiting final Congressional clearance to acquire 32 ex-Swiss air force Northrop F-5Es to replace aircraft operated by adversary squadrons. Meanwhile, the first two of 14 Lockheed Martin F-16A/Bs to be used for dissimilar air-combat training have been delivered to the Naval Strike and Air Warfare Center at NAS Fallon, Nevada.

By mid-2003 the F-16s, 10 single-seat As and four two-seat Bs from a batch of 28 built for Pakistan but never delivered, will have replaced a similar number of Boeing F/A-18As now used for air-combat training at Fallon. The Swiss F-5s will be delivered between 2003 and 2007 to replace 32 F-5Es operated by US Navy and Marine Corps reserve squadrons tasked with adversary training.

Swiss budget cuts increased the number of F-5Es available and made the purchase possible, says a US Navy official. Brazil, meanwhile, has signed a letter of intent to purchase 15 aircraft for conversion to two-seat trainers.

The US adversary F-5s are nearing the end of their airframe lives, averaging more than 7,000h. The Swiss aircraft have between 1,800h and 2,400h. The F-16s, meanwhile, have essentially zero hours on them. No

upgrades are funded, says the official. The F-16s are being made air-worthy and the F-5s will be cycled through Northrop Grumman's St Augustine, Florida, plant to replace radios and other Swiss-unique items with US equipment.

Although there will be no increase in the number of adversary aircraft, the higher availability of the F-16s and newer F-5s is expected to generate a greater number of training sorties. But there will still be a shortfall compared with the number of adversary sorties needed to meet US Navy and Marine Corps training requirements. Since 1995, when four of the original seven squadrons were decommissioned, the adversary programme has provided only a third of the sorties required, according to US Navy figures.

The F-5s simulate Category 3 threats, such as the Mikoyan MiG-21, and are used mainly during training at fleet replacement squadrons. The F-16s represent Cat 4 threats, such as the RSK MiG-29 and Sukhoi Su-27, and will be used for graduate-level dissimilar air-combat training during the work-up of carrier air wings and for Top Gun training at the Navy Fighter Weapons School. The US Navy operated 24 F-16N adversary aircraft until the mid-1990s.

DEFENCE

EADS Casa cleans up in Brazil

The Brazilian defence ministry has selected EADS Casa as the winner of two long-running air force competitions. The C295 has been selected to meet the CLX tactical transport requirement while the FITS maritime surveillance and anti-submarine warfare system has been selected to upgrade Lockheed Martin P-3B Orion maritime patrol aircraft.

Together the wins are potentially worth \$596 million, with local companies Varig VEM and Rolls-Royce Brazil due to provide services and technical support.

The CLX deal is worth \$326 million for 12 C295s, with a further 12 expected to be purchased after 2004. The transports will replace de Havilland Canada DHC-5 Buffalos and later BAe 748s. First deliveries are expected 18 months after contract signature.

Brazil's PX programme includes airframe and engine overhaul, and modernisation of eight of the 12 ex-US Navy P-3Bs acquired by the air force. Planning calls for the first overhauled and upgraded P-3 to be delivered 30 months after contract signature, which is expected in early 2003.

Briefing

IAI sells Harpy drones to China

ACQUISITION China has signed a \$100 million deal to acquire "a large number" of Israel Aircraft Industries (IAI) Harpy anti-radiation attack drones. China will receive the latest version of Harpy, which is equipped with a datalink that allows an operator in a ground station or airborne platform to allocate the weapon to a specific emitter. Harpy, manufactured by IAI's MBT division, is ground launched and flies to a pre-designated area where it begins a loitering pattern, seeking electromagnetic emissions. The latest Harpy variant is equipped with a dual electro-magnetic/electro-optical sensor.

Europe agrees industry measures

SECURITY The European Council and Parliament have agreed on new air transport industry security measures, according to council president Flemming Hansen. All staff and items entering airport secure areas must be screened, aircraft security on the ground is to be improved, and arriving and departing passengers in secure areas are to be kept separate. The council has agreed that random, unannounced security inspections may take place, and inspectors from one country may be part of a team that inspects airports in another.

Bulgarian government seals Balkan's fate

LIQUIDATION Balkan Bulgarian Airlines is to be liquidated after creditors, led by the Bulgarian government, voted to turn down a restructuring plan. For the last few months, Bulgarian transport minister Plamen Petrov has been seeking a new investor, having promised in August that "we would not allow the country to remain without a national carrier".

BWIA employees reject management plan

COST-CUTS BWIA West Indies Airways' future was in doubt late last week after employees rejected a cost-cutting plan. The Aviation, Communication and Allied Workers' Union (ACAWU), which represents over half of BWIA's 3,000 employees, voted to turn down most of the airline's management's proposals, aimed at saving \$300,000 a month. The union, as well as the Flight Attendants Association, voted to accept only minor cost cuts. Chief executive Conrad Aleong said in September that unless it could cut \$1 million in monthly costs the airline would go bankrupt.

Iraq accused of chemical warfare conversions

INTELLIGENCE Iraq has converted some of its Dassault Mirage F1 and Tupolev Tu-16 Badgers to carry chemical warfare agents, says the latest assessment by Israel's intelligence services. According to the assessment, Iraq has 30 operational Mirage F1s and a few Tu-16s and these have been modified to launch chemical warfare attacks on Israel as a response to a US attack. Previously the largest weapons-of-mass-destruction threat to Israel from Iraq was tactical ballistic missiles.

Eurofighter faces funding shortfall

BUDGET CUTS Alenia Aeronautica president Giorgio Zappa says the Italian defence budget cuts mean a €100 million (\$98 million) shortfall in the 2003 Italian Eurofighter funding. Italy should receive 29 of the first batch of 148 Eurofighters. To meet its 2003 commitments to the programme will cost Rome €100 million more than the €564.6 million contained in the budget proposal. Zappa says failing to meet its financial commitments to international agreements will have a negative impact on the programme's multi-year schedule and reduce confidence in Italy.

Swiss initiates cost-saving scheme

FINANCE Swiss International Air Lines has warned that it may not achieve its stated aim of breaking even next year, and has instigated a cost-reduction programme and recruitment freeze. Talks are under way with Embraer to delay deliveries of some of the six 170 regional jets it is to receive next year. The airline has blamed that move on the delay in the 170 certification programme, which has forced Embraer to push back deliveries.

AIR TRANSPORT BRENDAN SOBIE / WASHINGTON DC

A300 crash sparks pilot training row

Upset-recovery programme at the centre of investigation

The public hearing on the American Airlines flight 587 crash has developed into a clash between Airbus, the carrier and its pilots' union over what part a specialist upset recovery pilot-training programme may have played in the accident. The Airbus A300-600R crashed in November 2001 near New York Kennedy seconds after the tail fin separated from the aircraft following vigorous rudder movement.

Last week's hearing revealed that American was cautioned about its teaching on pilot-rudder input for roll recovery after an American A300-600R incident over Florida on 12 March, 1997. The pilots used rudder heavily in a stall recovery, overloading the fin, but causing no damage (*Flight International*, 5-11 March). The carrier says instructors in its advanced aircraft manoeuvring programme (AAMP) upset-recovery training would not have taught the excessive pilot rudder inputs that may have created high lateral aerodynamic loads just before AA587's fin broke off. American's pilots' union, the Allied Pilots Association (APA), insists the pilots performed according to their training and are now pushing for clearer guidance on rudder use.

Investigators are still trying to determine if pilot inputs, an anomaly in the rudder-control system, wake turbulence from a Boeing 747-400 or a combination of these factors led to the tail separation, because the flight data recorder (FDR) shows large rudder pedal movements and proportionate rudder deflection, but does not measure input pressure on the pedals.

The rudder movements occurred as the aircraft passed through wake turbulence from a preceding 747, but the hearing indicates that the inquiry is turning away from wake turbulence as a cause of the fin overload in favour of the sideslip generated by rudder displacement.

During the four-day hearing Airbus directed attention to American's AAMP training. The

course, taken by the AA587 pilots in 1997, teaches pilots of all aircraft types upset-recovery procedures, including the use of "co-ordinated rudder" in wake turbulence that results in high angles of attack (AoA). AA587 was not at a high AoA when the fatal upset occurred.

In a letter dated 22 May, 1997, the inquiry revealed, American A300 technical pilot David Tribout asked Airbus to "give us your thoughts" on the AAMP's teaching on the use of rudder to control roll in the event of a wake-turbulence encounter. Tribout called this part of the AAMP course "inaccurate and potentially dangerous" and asked whether "excessive use of rudder at high AoA might cause a spin or snap roll".

Airbus responded on 20 August 1997 with a guidance letter co-signed by Boeing and the US Federal Aviation Administration to American chief pilot Cecil Ewell warning: "The excessive emphasis on the superior effectiveness of the rudder for roll control vis-à-vis aileron and spoilers, in high AoA, is a concern." The letter says yaw dampers and automatic turn co-ordinators that deflect the rudder for balanced flight are adequate for recovery and "the manual application of rudder can defeat its purpose".

In a 12 August, 1998, letter to the NTSB supporting the investigation into the 12 March 1997 incident, Airbus warned: "Large or abrupt usage at high AoA can rapidly lead to large sideslip angles and can lead to rapid loss of controlled flight."

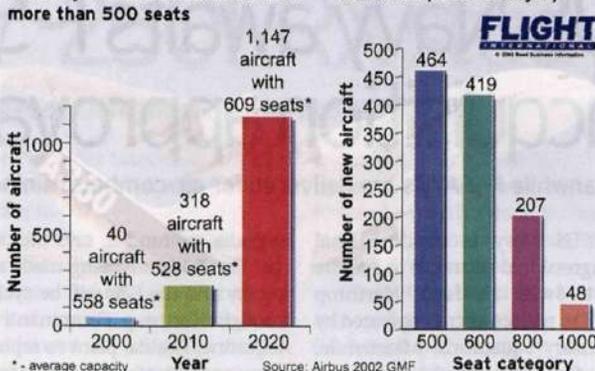
Despite this dialogue, American did not change AAMP, nor did Airbus issue an official advisory about rudder use. The carrier contends AAMP has saved lives and there is no reason to change it.

AA587's co-pilot was previously cited for applying excessive rudder, but American A300 fleet standards manager Delvin Young says there is no evidence the co-pilot did this more than once, insisting he would not have learned it from American.

AIRBUS 20 YEAR FORECAST FOR VERY LARGE AIRCRAFT

Passenger aircraft in service with more than 500 seats

Demand by seat category



BUSINESS MAX KINGSLEY-JONES / LONDON

Airbus sees reduced ultra-large demand

Airbus has published its first long-term market forecast for over two years, in which it predicts demand for almost 15,900 new passenger and freighter aircraft through to 2020, worth \$1,500 billion. Although its overall estimate is up around 8% in unit terms compared to the 2000 Global Market Forecast (GMF), the manufacturer has reduced its estimate for the size of the ultra-large-aircraft market in which the A380 will compete.

The two-year hiatus in publishing its annual GMF came as a result of last year's terrorist attacks. Airbus says that last year's forecast was about to be published when the attacks happened, and decided it would not be prudent to publish. The manufacturer says that it has taken 2000 as the base year "so as to avoid any distortion resulting from the unprecedented effects of 2001".

Airbus has simplified the categories into three passenger aircraft groups, and eliminated its previous "200-250 seater [A300/A310]" category (see table). It says that future demand for 210-seat widebody replacements "will be filled primarily by single-aisle types". The manufacturer has also not published its forecast for the 75- to 85-seat market, although it says that it has analysed the sector to understand the demand for 100-seaters like the A318.

The changes mean that direct year-on-year comparisons can only be made for very large passenger airliners and freighters. While the latter is effectively unchanged, Airbus has reduced the 500- to 1,000-seater forecast by almost 100 aircraft to 1,138 units. Boeing's latest 20-year forecast, published in July, puts the market for aircraft with 500 seats or more at just 330 aircraft (*Flight International*, 6-12 August).

Airbus's forecast demand for large cargo aircraft (greater than 80t payload) remains about the same, at just over 300 aircraft. Boeing's forecast for

the greater-than 65t payload freighter market is 220 units.

Airbus expects the ultra-large airliner fleet to grow steadily over the next 20 years to around 320 aircraft in 2010 and 1,150 by 2020, the bulk being 500 and 600 seaters.

Although Airbus has assumed world economic growth will be essentially unchanged from 2003, despite 11 September, it says "the crisis will have a lasting effect...the resultant shortfall in [business travel] revenue is unlikely to ever be recovered".

AIRBUS GMF COMPARISON

	2002 GMF Period 2001-20	2000 GMF 2000-19
70-85 seat	-	692
100-175 seat	-	7,570
100-200 seat	10,201	-
210-250 seat	-	3,046
250-400 seat	3,842	-
300-400 seat	-	2,118
500-1,000 seat	1,138	1,235
Freighters	706	703
Total	15,887	15,364
RPK/FTK* growth	4.7/5.5%	4.9/5.7%

* Annual revenue passenger-kilometres/freight tonne-kilometres

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START-UP MARY KIRBY / WASHINGTON DC

Caribbean competition heats up

Caribbean Sun Airlines set to go head-to-head with American Eagle while sister carrier Caribbean Star battles Liat

Start-up Caribbean Sun Airlines will compete head-on with American Eagle when it inaugurates services from San Juan, Puerto Rico, in December. The Florida-based sister company to Caribbean Star in Antigua plans to introduce turbo-prop flights to Antigua, St Kitts, the Leeward Islands, Tortolla, St Maarten and St Thomas.

US approvals are expected within weeks. Caribbean Sun hopes to

launch charters this month, followed by scheduled services a month later. The carrier will operate four Bombardier Dash 8s by the end of next year, but has tentative US permission to upgrade to 60-seat regional jets.

The creation of Caribbean Sun enables millionaire owner Allen Stanford to bypass the US Federal Aviation Administration International Aviation Safety Assessment

programme's Category 2 restrictions imposed on the Organisation of Eastern Caribbean States, which prohibit expansion of Caribbean Star flights from Antigua to the USA.

Caribbean Star already flies Dash 8s to a number of destinations proposed by Caribbean Sun, including St Kitts, Tortolla and St Maarten. Caribbean Sun will connect with Caribbean Star and provide one-stops throughout the region, much like American Eagle.

The carriers' rapid expansion plans and Stanford's deep pockets have put small Caribbean carriers on the defensive, as they are already suffering from the effects of 11 September.

Antigua incumbent Liat has been engaged in a turf war since Caribbean Star's start-

up two years ago. Tiny Nevis Express is facing restructuring after Liat launched services linking Antigua, Nevis and San Juan in preparation for Caribbean Sun's start-up. Nevis Express president Allen Haddadi says: "With the exception of American Eagle and Caribbean Star, we are all niche markets. Now, you have this war between Caribbean Star and Liat."

Meanwhile, a new unaffiliated company called Bermuda Star plans to create an airline offering services to Cologne, Germany, and Manchester, UK, as well as Chicago, New York Newark and Orlando in the US, with Boeing 757-200s and 767-200ERs.

The Austrian honorary consul in Bermuda, Leopold Kuchler, is forming Bermuda Star. The carrier would be the first Bermudan company to establish air services from the island in years and could pose a challenge to British Airways' weekly London Gatwick-Bermuda flights.



BOMBARDIER

Startup airline will connect with sister Dash 8 operator Caribbean Star

MARKETPLACE

- Cyprus Airways' new Greek low-cost airline **Hellas Jet** has agreed to lease three A320s from **CIT Aerospace**. The airline is due to launch services in April (*Flight International*, 2-8 July).
- **Vietnam Airlines** has signed a firm contract with **Airbus** to acquire five A321s as part of its long-term fleet expansion plan. The A321s are scheduled for delivery between 2003 and 2005.
- **Lion Airlines** has leased two ex-Aeromexico Boeing MD-82s from **CIT Aerospace**.
- **Air New Zealand** subsidiary **Mount Cook Airline** is to take delivery of an additional ATR 72-500 in January, bringing its fleet to 10.
- **Khalifa Airways** of Algeria is leasing two ex-British Airways Boeing 777-200s from **Boeing Aircraft Trading**. The General Electric GE90-powered aircraft will be delivered by the end of the year on five-year leases.

PASSENGER HEALTH DAVID LEARMOUNT / LONDON

Airlines urged to 'step up' incident response

The European Civil Aviation Conference (ECAC) has warned airlines to "step up" their response to passenger health concerns. An ECAC working group has been set up to report within six months on the action needed. If the industry fails to act on passenger health, ECAC predicts, medical incidents affecting passengers will increase.

Medical experts from the 38 member states of ECAC, ordered by the organisation's directors general, met in Dubrovnik, Croatia, at the end of October to "review the issue of passenger health in air travel and to identify action to be taken". They decided that "unless supplementary efforts are made, medical incidents affecting passengers in flight would rise". The growth in air travel, particularly in long-distance journeys, and the increasing numbers of older people flying

make passenger health an industry imperative, says ECAC. Recommendations include:

- developing and sharing scientific knowledge of in-flight medical incidents;
- developing common practice, particularly in on-board medical supplies and equipment, cabin crew training, air/ground communications and aircraft design;
- establishing the legal status of a doctor who volunteers to provide emergency assistance in flight;
- improving passenger information before travel;
- setting up an ECAC working group of all parties involved that would examine how the objectives could best be achieved and report on progress within six months.

ECAC says it will co-ordinate its actions with the International Civil Aviation Organisation.

SAFETY

T²CAS flight tests begin

Flight tests of Phoenix-based ACSS's T²CAS, a combined traffic collision avoidance system (TCAS) and terrain awareness warning system (TAW), have begun on the company's modified Beech King Air C90.

The system has been chosen by Aeromexico, FedEx Express, Northwest Airlines and Virgin Express, as well as the US Customs Service for installation on its Lockheed Martin P-3 fleet. Although flight tests had been expected to start in July, ACSS maintains the system will be certified by the end of the year and says initial TAWS functions have already been checked out.

ACSS, an L-3 Communications and Thales joint venture, is developing the T²CAS for new-build and retrofit applications, and expects to capitalise on its leading market position in existing TCAS equipment.

EXPANSION JUSTIN WASTNAGE / LONDON

KLM plans to make low-cost Buzz market leader

No-frills airline set to quadruple fleet and widen network coverage across Europe

KLM is to undertake massive expansion of its UK low-cost carrier Buzz, the centrepiece of the Dutch airline's strategy for the no-frills segment. Buzz will quadruple its fleet and expand its network in a bid to join EasyJet and Ryanair as a pan-European low-cost market leader.

Buzz operates eight BAe 146-300s and three Boeing 737-300s and earlier this year unveiled plans to expand its fleet with more 737-300s (*Flight International*, 14-20 May). The six new aircraft will arrive over three months from December, leased from International Lease Finance.

The new 737s will replace Buzz's 146s, which are being phased out

over two years from March, and Buzz chief commercial officer Tony Camacho says the aim is to have 30-40 737s in service within three to four years. "We are negotiating with a number of parties, but it is tricky to obtain batches of aircraft," he says, adding that the deals include upgrade clauses for Next Generation 737s.

Buzz will carry 1.8 million passengers in 2002, and the fleet expansion will give it the potential to expand to about 7 million a year. The airline was divested from KLM UK last week, and has acquired that carrier's air operator's certificate. KLM UK has been merged with KLM's wholly owned Dutch

regional KLM Cityhopper and will concentrate on Amsterdam feeder flights from points in the UK.

The new Buzz operation will continue to operate from its London Stansted base and will set up a new hub in Bournemouth, UK, early next year. It plans to have an offshore base in Europe before the end of next year. Buzz rules out using KLM's congested base at Amsterdam Schiphol and says Rotterdam is unlikely because the Dutch market is not big enough, and landing fees are still controlled by the Schiphol Group.

In lieu of a Buzz base, KLM is encouraging its charter subsidiary Transavia to expand its fares-only charter airline Basiq Air from Schiphol. The carrier will launch seven new routes from Amsterdam next April. Meanwhile, Transavia's "mainline" fleet will be dedicated solely to charter flights from Amsterdam, some of which will also be sold on a fares-only basis.

■ Ryanair will open its third mainland European hub at Milan's Orio al Serio airport in Bergamo, Italy, in February. Four 737s will be based there and 30 daily flights will be operated to Barcelona, Brussels, Frankfurt, Hamburg, London and Paris. Ryanair will increase daily flights between London and Milan to six, with two flights to Luton. From 20 February Ryanair will fly from Stansted to Girona, Spain, its first Spanish destination.

**ADDITIONAL REPORTING BY
HERMAN DE WULF IN BRUSSELS**

COMPETITION ANDREW DOYLE / SINGAPORE

SIA: no-frills no threat

Singapore Airlines (SIA) could rapidly adapt its regional subsidiary SilkAir to meet any threat from no-frills carriers attacking the Asian market, but such a scenario remains unlikely because of the slow pace of liberalisation, according to the airline's deputy chairman and chief executive Cheong Choong Kong.

Cheong says SIA has looked "in depth" at setting up a no-frills airline but has concluded that the business model being successfully exploited by the likes of EasyJet, Ryanair and Southwest Airlines would not necessarily work in Asia's "very regulated market". Cheong adds: "You have to have the traffic rights and a lot of the traffic rights to all the points we want to fly to have largely been exhausted."

Another factor is that the established flag carriers in Asia already offer lower fares than their US and European counterparts did before the no-frills carriers emerged. Cheong says SIA is prepared to meet any low-cost threat, possibly with a no-frills version of SilkAir, its full-service regional unit that flies nine Airbus narrowbodies. Meanwhile, SilkAir will launch a revamp in January to position itself as "SIA-lite", reports *Flight International's* sister publication *TravelWeekly East*.

FLEET RENEWAL

Volga-Dnepr signs for Antonov regional aircraft

Volga-Dnepr has signed a letter of intent with Antonov for seven regional aircraft - four An-140 turboprops and three An-148 regional jets.

The 52-seat An-140s will be delivered in 2003-04, while the 75-seat An-148s will arrive in 2005-06.

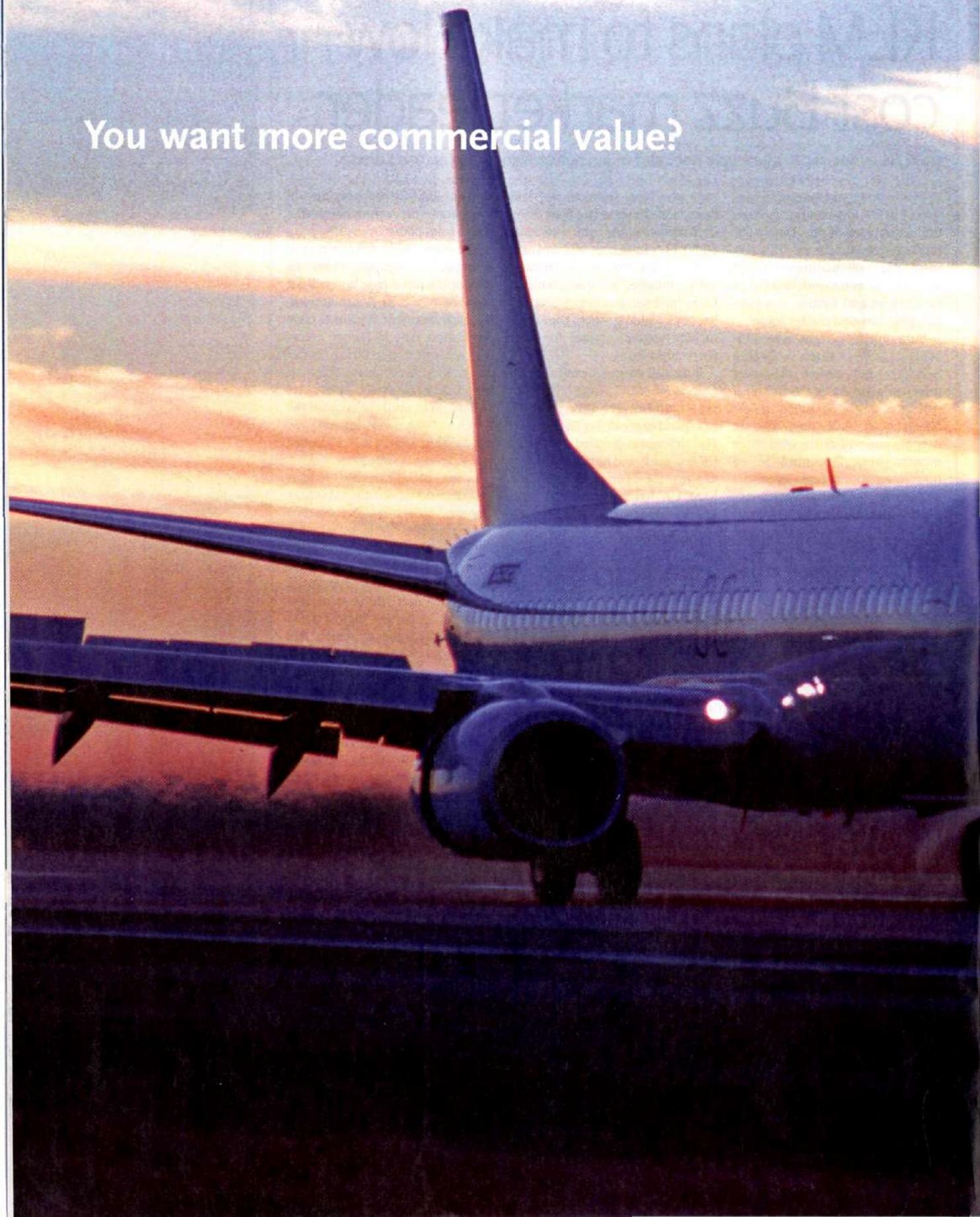
Aleksei Isaikin, chairman of the Russian airline and outside cargo carrier, says the An-140s will replace its ageing fleet of 32-seat Yakovlev Yak-40s. Isaikin adds that the An-148 will be deployed on routes from Moscow.

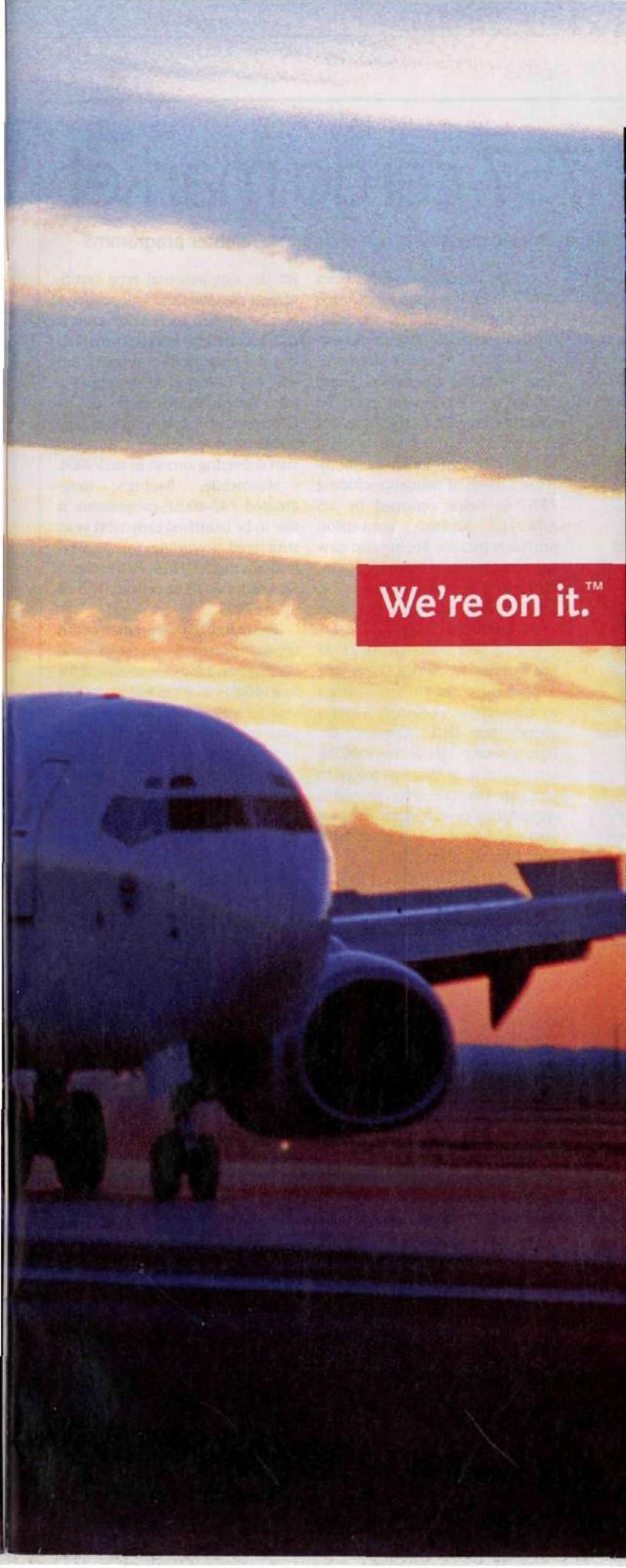
Volga-Dnepr is negotiating with

"several Ukrainian leasing companies" to provide the aircraft on either operating or financial leases. Isaikin says that "Russian and Ukrainian state authorities are negotiating a non-import-tax deal on aircraft produced in the two countries".

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FREIGHTERS ANDREW DOYLE / SINGAPORE

GECAS to enter 757 cargo market

Leasing company seeks to expand cargo aircraft portfolio as Boeing plans relaunch of Special Freighter programme

GE Capital Aviation Services (GECAS) plans to enter the Boeing 757-200 freighter leasing market and has received bids for conversion work from six potential vendors.

Meanwhile, Boeing is to restructure and relaunch its 757-200

Special Freighter (SF) programme in mid-2003 under the new business model it is adopting for its passenger-to-freighter (PTF) activities.

Faced with a depressed airline market, GECAS is seeking to boost revenue by rapidly expanding its

cargo aircraft portfolio with a series of PTF deals. "Freighter financing is complementary to our core business of passenger aircraft financing," says GECAS senior vice-president technical operations James Lindberg. "Our current portfolio contains excellent candidates for conversion."

The US lessor is looking at modifying a batch of twinjets including 757-200s being returned by US Airways. Known conversion providers include Boeing and new entrants Structural Integrity Engineering and Precision Conversions. Lindberg will not reveal the other three potential bidders.

Boeing will relaunch its 757SF programme in mid-2003 at the conclusion of the current contract to convert 34 ex-British Airways aircraft for DHL Airways, say Boeing sources. Under the existing arrangement, Boeing was forced to pick up the tab after problems arose during development and production. A total of 16 aircraft have been handed over to DHL.

Under the new business model, Boeing will charge a licensing fee

for the supplemental type certificate it develops and will receive a royalty for each aircraft delivered. It will also handle sales and marketing and offer product support, but will not invest in setting up the line, manufacture parts or be responsible for touch labour. The restructured 757SF programme will start delivering aircraft in mid-2004.

Meanwhile, Boeing's long-awaited 747-400SF programme is due to be launched early next year, structured according to the new business model (*Flight International*, 8-14 October). First delivery will be in late 2005.

The manufacturer is talking with several potential investors and licensees and forecasts demand for four -400SFs in 2006 and six to 10 a year thereafter, which "could support two to three touch labour partners", say the sources.

Meanwhile, Boeing is preparing to offer special freighter versions of the 767-200 and -300, 737-300, and possibly the MD-80. Under the old structure, Boeing found it difficult to price conversions competitively.

SEE BUSINESS P24

PARTNERSHIP

SIA Engineering hopes to be 747-400 conversion provider

SIA Engineering is in talks with Boeing to become an approved provider of 747-400 passenger-to-freighter conversions when the US manufacturer formally launches the programme.

"We have always said that if the yields were right, we would move into cargo conversions," says SIA Engineering chief executive William Tan. The company is in discussions with Boeing about doing work under the manufacturer's supplemental type certificate, but has yet to decide whether to proceed, says Tan. Boeing is currently seeking a launch customer for the 747-400 Special Freighter.

Entering the freighter conversion market would bring SIA Engineering into competition with its compatriot, Singapore Technologies Aerospace.

The majority-owned Singapore Airlines (SIA) maintenance subsidiary reported a 4% increase in net profit for the six months to the end of 30 September. It has managed to weather the economic downturn by concentrating on newer aircraft types such as the 747-400, Boeing 777 and Airbus A320 where competition among overhaul providers is less fierce, and is reducing its reliance on captive SIA business by building up its third-party customer base.

EXPANSION

Canadian tour operator to double fleet

Conquest Vacations is undertaking a major expansion of its network which will see the Canadian tour operator's fleet double in size.

The company, Canada's biggest independent tour operator, is embarking on a C\$1.2 billion (\$770 million) expansion over five years, with a series of new services planned to operate to Europe, the Caribbean, Florida, Hawaii and South America. Funding for the expansion is being generated internally from operations.

By the end of the year, Conquest will add three Airbus A319s and one A330 to its fleet of one A319 and four A320s. By the second quarter, two Boeing 757s will be



Under Conquest's \$770 million expansion, three A319s will join its fleet, together with an A330 and two Boeing 757s

introduced, taking its fleet to 11 aircraft, all of which will be operated by its Toronto-based partner Skyservice.

"The expansion plan takes into consideration current market conditions and responds to demand for more specific destinations," says Conquest president Robbie Goldberg.

Conquest introduced domestic services last February following the

bankruptcy of Canada 3000 in November 2001, and Goldberg says it is now carrying more passengers domestically than it did with Canada 3000. Overall load factors average 91% and Goldberg expects to more than double domestic capacity next summer.

Part of the expansion includes the start of transatlantic seasonal services in May using Boeing 757s from Toronto and Vancouver and

possibly Calgary to Belfast, Glasgow, Lisbon, London and Manchester.

Discount Canadian airline Jetsgo plans to double its fleet from three to six Boeing MD-83s by the year-end. The Toronto-based carrier is expanding domestic services with new flights to Timmins, Ontario; Saguenay, Quebec; and Charlotte-town, Prince Edward Island; as well as its first services to the USA.

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INVESTIGATION

Taiwan study highlights metal fatigue

Investigators are examining large metal fatigue cracks near a rear door on the China Airlines Boeing 747-200 that crashed into the sea on 25 May. Taiwan's Aviation Safety Council (ASC) has called a halt to further salvage work, having recovered about 80% of the wreckage and 175 of the 225 people on board.

"At the moment we can only say that a metal fatigue crack located at the aircraft's No 5 rear door was larger than expected," says ASC chief Kay Yong.

Twenty minutes after take-off from Taipei for Hong Kong, the 747 was seen clearly on military radar to have broken into four sections that fell into the sea.

Yong cautions that the information released is factual data, not a judgement of the cause, but adds there is no evidence of pilot error or technical problems. Yong says weather and terrorism have been ruled out.

The ASC does not expect to publish its final report before September 2004.

ASC members say repairs to damage in the tail section of the 22-year-old aircraft almost 20 years ago may have been a factor in the fatigue cracks.

COMMUNICATIONS EMMA KELLY / LONDON

Eurocontrol considers Link 2000+ incentive

Air navigation authority may offer ATS providers scheme to speed up programme

European air navigation organisation Eurocontrol is considering offering air traffic services (ATS) providers a "pioneer scheme" to support them in upgrading control centres for datalink communications, in a bid to speed up implementation of Europe's Link 2000+ programme. The move follows an incentive scheme for airline datalink pioneers, now being finalised, which will include testing and implementation support and reduced navigation charges.

Link 2000+ will involve implementing en route communications via VHF datalink mode 2 (VDL-2) in 11 European states from 2003 to 2007. Datalink communications, replacing voice, are considered necessary to enable the European air traffic management system to handle growing traffic. It is expected to reduce the communication workload for air traffic controllers and pilots, increase communication reliability and allow information to be exchanged between airborne and ground-based systems.

The pioneer scheme, which is being put to ATS providers this

month, would see Eurocontrol give support by upgrading equipment and providing test facilities and resources at its Bretigny experimental centre, says Alex Wandels, Eurocontrol's Link 2000+ programme manager. Eurocontrol's Maastricht centre already supports datalink communications following its pioneering Preliminary Eurocontrol Test of Air/Ground Datalink (PETAL) project, conducted between 1998 and 2001.

"We want to grow Link 2000+ from Maastricht outwards," says Wandels. The service providers of Austria, the Benelux countries, France, Germany, Italy, Spain and Switzerland have all committed to Link 2000+, with more expected.

The scheme is intended to speed up ATS providers' move to datalink at a time when airline "movement is accelerating", says Wandels. Lufthansa has already committed to the programme, but its Honeywell avionics are unlikely to be certificated until 2004. Other airlines talking to Eurocontrol about their datalink plans include

Air France, Alitalia, British Airways, Iberia, KLM, Scandinavian Airlines and Swiss International Air Lines. "We are beyond the operational convincing stage," says Wandels, adding that airlines recognise the operational advantages datalink communications will bring.

To convince airline finance departments of the need to upgrade for air traffic control datalink - which costs about \$20,000 if an aircraft is already VDL-equipped for airline operational communications - the first 100 aircraft to participate in the programme will receive testing and certification support from Eurocontrol, and an incentive scheme could offer reductions on route charges. A final incentive proposal is due to be presented to ATS providers this month.

Eurocontrol is aiming for 25% of the fleet operating in Europe to be equipped by 2007, although it concedes this is ambitious. The organisation will hold a workshop in Brussels in December, which is designed to bring airlines and ATS providers together.



DELIVERIES

Qantas increases widebody fleet with first A330 and 747-400ER

Qantas is expanding its widebody fleet by introducing its first Airbus A330 and Boeing 747-400ER. The airline is about to take delivery of the first of 13 A330s it has on order,

and recently received the first of six 747-400ERs, for which it placed the launch order in December 2000. Both types are equipped with General Electric CF6-80 engines.

The airline has seven A330-200s and six -300s on order as part of a major Airbus deal that included 12 A380s. Meanwhile, the 747-400ER, which has increased weights, fuel

capacity and 800km (435nm) more range than the standard -400, entered service last week on Qantas's route between Sydney and Los Angeles.



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PRODUCTION PAUL DUFFY / MOSCOW

Russia prepares for plant shake-up

Legislation is in the pipeline to bring aircraft production plants in Kazan and Taganrog under Tupolev

A government-driven reorganisation of Russia's aircraft production plants is set to further consolidate the country's fragmented manufacturing industry.

The Russian government is preparing legislation to restructure the Kazan Aircraft Production Association (KAPO) in Tatarstan and the Tavia factory in Taganrog to bring them into the holding group of design bureau Tupolev, which already controls the Aviastar plant in Ulyanovsk. The integration process is expected to take until 2004 to complete.

KAPO produces the longer-range,

increased-gross-weight version of the Tupolev Tu-204-100 twinjet, designated the Tu-214, and delivered the first example in May last year. The baseline Tu-204 is built by Aviastar, which also plans to build the extended-range version under the Tu-204-200 designation.

Tupolev says that, with the two plants effectively competing with each other, potential Tu-204/214 customers are playing one against the other to get the best deal. Having both factories under the group's umbrella is expected to eliminate this competition.

Tavia is involved in the produc-

tion of Beriev amphibians and the Be-132MK regional turboprop, as well as the 100-seat Tupolev Tu-334 short-haul twinjet. Separate efforts are already under way to integrate the partners on the Tu-334 programme, for which Aviastar is manufacturing the horizontal stabiliser and noses.

Although the Tu-334 prototype has been in flight testing since February 1999, the programme has progressed slowly. However, funds have been secured from the Russian aerospace agency to pay for its systems and engines, and efforts are being made to complete

the first production aircraft to enable it to join the test programme and to finish the certification process.

Tupolev chairman Igor Shevchuk says that once the Tu-334 programme is back on track, work will start in earnest on the Tu-330 airlifter for the Russian air force, which has placed an initial order.

■ Tupolev is to respond to the Russian minister of transport's recent tender for the supply of 200 regional aircraft with a bid based around the planned all-new 52-seat Tu-324 regional jet and a stretched 75-seat version, the Tu-414.

RESTRUCTURE MAX KINGSLEY-JONES / BIRMINGHAM

British Airways pushes ahead with UK operations reorganisation

British Airways has partly completed the reorganisation of its UK operations, involving the merger of regional divisions under the CitiExpress brand and the reallocation of aircraft between Birmingham, London Gatwick and Manchester.

The move, which is key to the airline's Future Size and Shape review, is due to be completed by the start of its 2003 summer schedules at the end of March. Recently acquired British Regional Airlines (BRAL) has been merged with its wholly owned Brymon Airways

arm, which forms the basis of the CitiExpress operation.

The other element of the reorganisation is restructuring the BA Regional (BAR) operations at Birmingham and Manchester. These are being brought into the CitiExpress grouping, while ex-BAR Airbus A319s and Boeing 737s are being redeployed to the London airports with BA mainline and replaced by smaller, 110-seat, ex-CityFlyer Express BAE Systems Avro RJ100s which are transferring to the UK regions.

BA general manager UK business

David Evans says the reorganisation is about one-third of the way through. "In September, the [former BRAL] Manx brand was eliminated, with its flight code and aircraft coming fully into the BA fold. Six ex-CityFlyer RJ100s have been transferred from Gatwick...from April the CitiExpress fleet will total 84 aircraft."

Evans says the restructured fleet will comprise 13 BAe ATPs, 12 BAe Jetstream 41s, five BAe 146s, 16 RJ100s, 10 Bombardier Dash 8s, and 28 Embraer ERJ-145s. "After the reorganisation, our capacity at Birmingham will be about 9% lower, and Manchester will be about the same as before."

The redeployment of fleets between the three UK airports has enabled some ex-CityFlyer RJ100 pilots to switch to the mainline operation if they want to remain at Gatwick, says Evans. Similarly, ex-BAR pilots have had the option to move on to the CitiExpress fleet if they want to remain at their current bases.

Additional RJ100 pilots are being sourced from the CitiExpress turboprop and ERJ fleets where necessary.

FLEET DEVELOPMENT

Air Sahara thinks about A320 switch

Indian carrier Air Sahara is considering replacing its 10 leased Boeing 737s with Airbus A320s.

The carrier is studying proposals to acquire 11 A320s on lease and purchase arrangements and the first aircraft could be flying as early as next year. Its 737s would be phased out over several years, although the carrier says there is no guarantee it will go ahead with the switch.

"We are still waiting for some decisions on whether we will go in that direction," says the airline. "We are still considering it, as it would require phasing out 737s."

Air Sahara, India's second-largest private airline after Jet Airways, operates 10 leased 737s - three -400s, five -700s and two -800s - and recently agreed to lease further examples of the type.

Meanwhile, the carrier says it is still planning to launch domestic feeder operations using Bombardier CRJs. Discussions are continuing with lessors, but Air Sahara says its plans are "going very well" and the first aircraft could be flying before the end of the year.



KEITH GASKELL

Redeployment of ex-CityFlyer RJ100s from Gatwick is under way





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COUNTERMEASURES GRAHAM WARWICK / WASHINGTON DC

BAE and Raytheon vie for USAF decoy deal

BAE Systems and Raytheon are competing to equip US Air Force special operations Lockheed Martin C-130s with towed decoys. BAE is offering the ALE-55 fibre-optic towed decoy (FOTD) under development for the Boeing F/A-18E/F, F-15 and B-1B, while Raytheon is proposing a fibre-optic upgrade of its ALE-50 decoy, dubbed the FO-50.

Both companies have flight-tested FOTDs on the C-130. Prime contractor Boeing is looking for a reel-out/reel-in decoy for MC-130 Combat Talon I/II and AC-130 gunships. Two underwing pods will each house four decoys, capable of rapid launch and recovery, connected by fibre-optic towline to the aircraft's jamming system.

BAE's ALE-55 is in flight testing on the F/A-18, where the decoy is deployed from a canister mounted between the engines. After problems with afterburner plume impingement on the towline causing burn-through, the US Navy has flight tested a temperature-resistant

fibre-optic line. The towline withstood more than triple the required duration immersed in the afterburner plume and maintained optical and electrical continuity, says Mike Williams, director of radio-frequency countermeasures programmes at BAE Systems Information & Electronic Warfare Systems.

The high-power FOTD is scheduled to become operational on the F/A-18E/F in 2005 as part of the Block 3 integrated defensive electronic countermeasures (IDECM) system. The Block 1 system now in service uses the ALE-50, and the IDECM Block 2 scheduled for deployment in 2004 will combine the Raytheon decoy with the BAE/ITT ALQ-214 jamming system planned for the Block 3 version.

The ALE-55 is also planned for the B-1B, although Raytheon's private-venture FO-50 is being eyed as an alternative. Flight testing of the F-15's ALE-55, using the high-temperature towline developed for the F/A-18, is planned to start in 2004.



DELIVERY

Italian army receives upgraded Mangusta attack helicopters

Agusta has delivered the latest version of the A129 Mangusta attack helicopter to the Italian army. The army ordered 15 A129CBTs in 1999. The CBT configuration includes a nose-mounted 20mm cannon turret, compatibility with the air-to-air version of the Raytheon Stinger surface-to-air missile, and updated mission avionics and electronic warfare system. The dynamic system has also been upgraded with five-blade main rotor, Rolls-Royce Gem 1004 engines, and a strengthened transmission that can absorb 1,270kW (1,700shp) compared with the original 970kW. The 45 Mangustas already in Italian army service will be upgraded to CBT standard once the last new-build machine has been delivered.

ACQUISITION STEWART PENNEY / LONDON

Training woes blight Apache plans

Significant numbers of the UK's Apache AH1s are to be stored pending completion of pilot conversion courses in 2007

The UK's National Audit Office (NAO) has criticised the Ministry of Defence's acquisition of 67 Westland Apache AH1 attack helicopters. Although deliveries are running to timetable and the programme is less than 2.5% over budget, training is two years behind schedule.

The Apache will be the cornerstone of the British Army's air manoeuvre capability, says the NAO, which has studied the "six lines of development" used by the MoD to acquire a capability rather than just the platform.

The NAO says all aircraft will be delivered by April 2004, and will receive all enhancements covered by contract changes by mid-2005, but risks and concerns remain. These include damage to the

machine from firing the Lockheed Martin AGM-114 missile and Bristol CRV7 rocket, spares provision and the operation of some systems.

But the biggest issue is training, which should have begun in September last year and is now due to start in September 2003. Training was to be part of the prime contract for the machines, but two years after the prime contract was signed, training was placed under a separate, 30-year, £1 billion (\$1.55 billion) private finance initiative-funded programme awarded to Boeing/Westland joint venture Aviation Training International (ATIL).

The main problems have been simulator development delays, late delivery of training materials and longer-than-planned courses. As a

result, significant numbers – perhaps half – of the Apaches will have to be stored, at a cost of £6 million. The late delivery of training materials cost the MoD £34 million because it had contracted for training courses that could not be run.

Simulator problems included late delivery of the Evans & Sutherland Harmony visuals system and, although the device entered service last December, it required software enhancements, says the report.

Also, it was planned for Apache pilot conversion courses to last 15 weeks, but this has been extended to 26 weeks, which means completion of conversion training for 144 pilots has slipped from April 2004 to February 2007. As simulator hours are capped under ATIL's contract,

the number of pilots trained each year has fallen from 72 to 48. The MoD says it is considering ways of reducing the timescale without reducing the training's effectiveness.

NAO recommendations include that the MoD should consider at the outset the costs, benefits and impact on risk of removing elements – such as training – from the prime contractor's responsibility; and that assumptions about key processes and activities, such as course lengths, should be supported by credible evidence.

The MoD says it welcomes the report and has been addressing the issues for some time. It says procurement minister Lord Bach has raised the issue with the contractors and received assurances that there will be no more delays.

AERIAL REFUELLING PETER LA FRANCHI / CANBERRA

Australia plans tanker competition

Airbus and Boeing are the main bidders for the tanker requirement, with new-build aircraft favoured

Australia plans to launch a competition for four tanker aircraft in January with the first required to enter service by December 2006.

The tender will include options on a fifth aircraft, an upper deck cargo door to give the aircraft a dual role as freighters, and an electronic warfare suite common with the Royal Australian Air Force's Boeing Wedgetail airborne early warning and control aircraft.

The draft bid documents were released by the Australian Defence Materiel Organisation last week for

industry comment, with the tender to close in April 2003 and selection planned for mid-year. Contract signature should be in early 2004 with all aircraft in operational service by December 2008.

Although the government has earmarked A\$1.7 billion (\$942 million) in the May 2003 defence budget, final approval is required before the project can start.

The new tankers are to have probe-and-drogue and boom refuelling equipment. The draft tender calls for the ability to offload

54,500kg (120,000lb) of fuel up to 1,665km (900nm) from base, and remain on station at that range for 90min. At 740km, the requirement is to deliver 65,375kg of fuel while remaining on station for 90min.

The draft expresses a clear preference for new-build tankers, but says converted near-new aircraft will also be considered if they comply with all requirements. The two main contenders for the tender are Airbus, which is expected to announce this week whether it will offer an A310 or an A330 platform, and Boeing,

offering its 767 Tanker-Transport.

The new tankers will support the RAAF's BAE Systems Hawk 127s, Boeing F/A-18s, General Dynamics F-111s, Lockheed Martin C-130Js, and the Wedgetails. The RAAF's Boeing 707s are restricted to refuelling the F/A-18s.

The new tankers are expected to have a 20- to 30-year service life. Plans for an interim leased fleet to replace the 707s were abandoned last year due to costs and a 707 life extension project has since been carried out by Boeing Australia.

DISPOSALS PAUL LEWIS / WASHINGTON DC

Retired US Army AH-1F and UH-1H fleet attracts international interest

The large number of retired US Army Bell AH-1F Cobra and UH-1H helicopters is interesting a number of nations requiring new capabilities, as well as existing operators of the machines wanting to bolster their fleets. Meanwhile, the US Department of Defense is reviewing its support structure for the two types, which are due to disappear from the army's inventory.

The US Army, Army Reserve and National Guard have retired almost 400 AH-1Fs since unveiling their aviation modernisation plan in March 2000.

Most are parked at Ft Drum, New York, awaiting disposal. The army is also phasing out more than 700 UH-1Hs, with the last retirement scheduled by 2004.

Countries interested in the single-engine AH-1s include Argentina and Bahrain, which have submitted letters of request for 12 and 17 machines respectively.

Argentina was earmarked for machines last year, but was forced to delay the \$4 million deal because of its financial crisis. Bahrain plans to refurbish 14 Cobras and use the rest as spares to support its existing 12 AH-1s.

Another Cobra operator, Israel, was allocated 15 of the helicopters



Countries interested in the AH-1s include Argentina and Bahrain

stored at Fort Drum last year and is understood to be seeking a similar number this year. According to US officials, Portugal and South Korea are also interested in acquiring machines, while Chile is seeking information on acquiring new or secondhand attack helicopters.

Thailand, however, has rejected a US offer of six AH-1s and 30 UH-1Hs. Other UH-1H offers include one machine for Brazil, six for Chile, six for Honduras, 18 for Tunisia and six for Uruguay. US

offers of used helicopters have not always been a success - Mexico returned 72 UH-1Hs in 1999 because of airworthiness issues. Other surplus machines were recently delivered to Georgia.

With the retirement of the US Army's last UH-1H, support could become more of an issue for foreign operators. As a result, the DoD is developing a new "fair share sustainment" programme to replace the army's support centre by September next year.

MAINTENANCE

French air force grounds Hercules

All 14 of the French air force's Lockheed Martin C-130H/H-30 Hercules have been grounded since 18 October following maintenance problems.

Portugal's state-owned OGMA military maintenance company won a six-year contract for the aircraft in June, beating incumbent French company Sogerma to the deal.

OGMA says it "recognises that there were difficulties at the beginning of the contract, mainly due to the short transition period for this agreement". It adds that it has taken several measures to "rapidly improve the situation", including a partnership deal with Lockheed Martin "for the supply of all necessary parts".

OGMA says: "The recovery plan is in place and results are expected within the very near-term, starting with an increased fleet availability this week."

Portuguese defence minister Paolo Portas announced last week a €50 million (\$49 million) loan to OGMA. Company president Miguel Morais Leitao says: "This loan will not solve OGMA's problems, but it's a first step."

The air force says the problem is "certainly transitory".

TRAINERS ANDREW DOYLE / KUALA LUMPUR

Malaysia mulls MB339 purchase

Aermacchi fighter trainers being offered for sale by Ernst & Young on behalf of New Zealand government

Malaysia is negotiating to buy 17 ex-Royal New Zealand Air Force Aermacchi MB339CB lead-in fighter trainers, being remarketed by Ernst & Young on behalf of the New Zealand government.

The consultancy has made an offer to Malaysia, but funding could be a problem because the country is prioritising the acquisition of an airborne early-warning capability, Boeing F/A-18F Super Hornet and Sukhoi Su-30 fighters, and army and navy helicopters.

A decision by Malaysia to acquire New Zealand's MB339s would be a setback for BAE Systems, which is trying to secure a follow-on Hawk purchase. Even if the MB339 deal is concluded, however, the UK company could still benefit from a Hawk attrition purchase later this decade.

"BAE Systems recognises the Malaysian air force's need for more trainers and is discussing the situation with the customer," says the manufacturer. "A Hawk solution is

on the table and it is up to the customer to decide."

Ernst & Young declines to comment on discussions with Malaysia, but confirms it is talking to several potential buyers for the MB339s, which were built in 1991-4 and are available with a full spares package.

Aermacchi and engine maker Rolls-Royce are assisting Ernst & Young's attempts to place the aircraft. New Zealand put them up for sale in August last year following the disbandment

of the air force's air combat wing.

Malaysia has eight early-model MB339A trainers, but would need to expand its support infrastructure for the type significantly if it bought the MB339CBs.

BAE has been working with the Malaysian air force and local companies Airod and Zetro Aerospace this year to improve serviceability rates for the country's 24 Hawk 100/200s, and the UK company says the availability rate is expected to exceed 90% by year-end.

DELIVERY

Israeli air force receives first three of 27 Grob 120 trainers

The Israeli air force has received the first three of 27 Grob 120A1 trainers. The aircraft will be operated by Snunit Aviation Services, created earlier this year by Elbit Systems and its subsidiary Cyclone Aviation to provide flight screening and initial training for the air force for 10 years. To be known as the Snunit in Israeli service, the Grob 120 replaces elderly Piper PA-18-150 Super Cubs and takes over some of the tasks allocated to the Fouga Zucit (CM170 Magister). This is the first deal by the Israel air force using a concept similar to the UK's private finance initiative.



RECONNAISSANCE

Italy studies Mirach UAV

Meteor-CAE has won an Italian defence ministry study contract for a tactical reconnaissance unmanned air vehicle derived from the turbojet-powered Mirach 100/5 target. Deliveries could start in May 2004.

The company has also received money to develop automatic take-off and landing systems for the UAV and a contract to provide Mirach 100/5 drones to test the multinational IRIS-T infrared-guided air-to-air missile.

The reconnaissance UAV and the automatic take-off and landing systems will be 50% funded by Meteor, which is already developing the Mirach 100/5-derived Nibbio and the piston-engined Falco UAV.

UPGRADES VLADIMIR KARNOZOV / MOSCOW

Russian acceptance trials begin for revamped Frogfoot strike aircraft

The Russian air force has started acceptance trials of the upgraded Sukhoi Su-25SM Frogfoot strike aircraft after a year-long manufacturer's test programme.

The Su-25SM has a Panthera GPS satellite navigation-based weapons system and is compatible with laser- and TV-guided munitions. Unlike standard Su-25s, the upgraded aircraft is equipped with a forward-looking infrared (FLIR) system and can operate at night.

Vladimir Babak, general director of the Sukhoi Attack Aircraft consortium, says the air force test programme will last a year.

Only one Su-25SM has been built, although a second will be completed by year-end. Next year,

the air force's maintenance centre in Kubinka is scheduled to upgrade three Su-25 single-seaters as well as modifying an Su-25UB twin-seat into a Su-25UBM.

The Su-25SM fills some of the capability gap created by a lack of funds to procure the Su-25T, which is equipped with the Shkval optical sight used with the KBM 9K121 Vikhr (AT-16) supersonic laser-guided anti-armour missile. A single Su-25T squadron is in Russian air force service.

Meanwhile, Russian air force trials of the Mil Mi-24PN night-capable combat helicopter at the Akhtubinsk flight-test centre are set to be completed by year-end.

The Mi-24PN upgrade includes a

modified cockpit, Krasnogorsk Optics' Zarevo infrared sighting system, fifth-generation night vision goggles and Kolomna 9M120 Ataka missiles.

The Russian armed forces have ordered upgrades of 120 Mi-8s and Mi-24s to the night-attack variants, says Aleksei Samusenko, general designer of Mil's Moscow helicopter plant.

Mil is offering two PN sub-variants: the PN-1, with the Mi-24's original rotor system and a fixed undercarriage replacing the earlier retractable gear; and the PN-2, which has a rotor system developed for the Mi-28N with new main rotor blades and a tail rotor with offset blades.

NAVAL AVIATION STEWART PENNEY / LONDON & PAUL LEWIS / WASHINGTON DC

STOBAR considered to meet CVF requirement

Competitors seek solution to allow fixed-wing operations from the UK's future carriers

Bidders to design the UK's CVF future aircraft carrier are turning their attention to short take-off but assisted recovery (STOBAR) as a means of operating large fixed-wing aircraft. BAE Systems and Thales will conclude phase two of the CVF competition this month, with a winner to be selected in January.

The Ministry of Defence decided earlier this year that the CVF would be a conventional carrier, but equipped to operate the short take-off and vertical landing (STOVL) variant of the Lockheed Martin F-35 Joint Strike Fighter (*Flight International*, 8-14 October).

STOBAR, which uses a bow ski-jump rather than a catapult to launch the aircraft, coupled with arrestor gear to aid recovery, is not sanctioned by the MoD, which is concentrating on STOVL operations, say industry sources. STOBAR, however, would allow the RN to operate a fixed-wing aircraft to meet its Maritime Airborne Surveillance Capability (MASC) requirement for organic airborne early warning and control. BAE and Thales have MASC study contracts.

Limiting CVF to STOVL operations means MASC is restricted to a helicopter or the Bell Boeing V-22 Osprey tiltrotor. The RN is not keen to have a helicopter MASC because

it will have altitude, range and speed shortfalls compared with fixed-wing platforms, say sources.

Northrop Grumman is studying the feasibility of operating the E-2C Hawkeye from the CVF. The company says: "Based on the questions we're getting from the customer, nothing has been ruled out and we're being told to go forward to the initial [decision] and that all options are still on the table."

Northrop Grumman says "a certain amount of work" has been done on looking at E-2 take-off using a ski-jump, such as trading take-off roll for fuel. A related but separate study is considering alternative powerplants, which may be

a feature of the US Navy's planned Advanced Hawkeye, targeted for service entry in 2010.

The USN is keen for the RN to join the Advanced Hawkeye/Radar Modernisation Programme. But UK officials say the E-2 is regarded as too expensive. A Thales source says the company has identified another, cheaper, fixed-wing platform that could carry the radar and mission system from the Westland Sea King AEW7, which is the MASC baseline equipment.

A UK official says the V-22 would be a better MASC platform than a helicopter, but the price of the green airframe would have to be reduced to make it affordable.



BAE (left) and Thales are competing to supply the CVF

UNMANNED SYSTEMS

Shipborne UAV projects launched by France

French procurement agency DGA says it is launching two projects with research agency ONERA to develop a tactical maritime unmanned air vehicle (UAV) "to complement and in some cases replace functions currently served by boats". It plans to fly demonstrators by the end of next year.

"Ships can only see as far as the horizon, about 35-40nm [65-75km]," says Pierre Grandclément, DGA's head of seaborne air systems. "So, to see further, you must go higher, and to do that you need to have aircraft or UAVs...and aircraft are pricier."

One project envisages turning a helicopter into a UAV, "replacing the pilot with a CD-ROM", says Grandclément.

The second programme is a small, rotary-wing UAV that can land "on a relatively small, moving object: a ship".

Once this is achieved, "then we will look at what kind of payload we could put on it - our aim is to find the best compromise between airframe and payload", he adds.

Grandclément says the shipborne UAV "will be essentially dedicated to surveillance and only in a second phase will we consider arming it".

■ French UAV specialist Sagem is confident Spain will select the Sperwer tactical system within the next two years.

More than 10 companies have briefed Spain on their programmes, but senior Spanish military officials say Sperwer is the favoured solution. Sagem adds: "It does appear that our solution is the one that interests them, but there is the problem of a lack of budget."

Meanwhile, Greece has ordered three Sperwer systems. As part of the deal, the UAV's operating radius from the ground station has been increased by 50km to 200km.

FIGHTER ACQUISITION

Decision due soon on Brazil's FX-BR

Brazil's FX-BR fighter procurement programme is expected to accelerate again after the election of a new president late last month.

The incumbent Brazilian president and his successor, Luis Inácio Lula da Silva, will hold meetings in the first half of this month to decide jointly a number of issues, including the final decision on the long-delayed FX-BR programme.

At the start of Lula's campaign,

the Embraer/Dassault Mirage 2000BR proposal was favoured politically because it would create the most jobs in Brazil's aerospace industry. But recent statements by Lula suggest this has changed, with the president indicating he will stick with the Brazilian air force's first choice, the Sukhoi Su-35.

No decision has been taken on leasing an interim fighter to replace ageing Dassault Mirage III/EBR/

DBRs until the winning FX-BR enters service. Israel Aircraft Industries appeared to have concluded a deal for 12 Kfir C-10s, but Varig VEM has entered the ring with a proposal for 18 ex-Royal Netherlands Air Force Lockheed Martin F-16A/Bs. Valued at \$113.4 million, the proposal includes overhauling 16 F-16As and two F-16Bs at Varig's Rio de Janeiro maintenance facilities.

FINANCE KAREN WALKER / WASHINGTON DC

General Electric exposed to troubled US airlines

Leasing giant says it is secure, although analysts are shocked by size of commitments

General Electric's revelation that it has more than \$4.4 billion exposure to struggling US Airways and United Airlines has highlighted the vulnerability of leasing and financing arms of aerospace manufacturers.

GE revealed the extent of its exposure last week, saying it has been in talks with US Airways, which is in Chapter 11 bankruptcy protection, and United Airlines, which is threatening to follow suit. The exposures include loans, leases and other financing commitments, the majority of them through financing arm GE Commercial Finance and lessor GE Capital Aviation Services (GECAS).

GE, which posted a \$4.1 billion net profit for the 2002 third quarter, says it has made provision for "probable losses", but stresses that

exposure is secured against individual aircraft or pools of engines.

The extent of the exposure has shocked some observers. "That's a lot of money, even for a company of their size," says one analyst. "Even if they are secured, it will take time, effort and cost to move aircraft in the current market."

Boeing's financing arm revealed in a second-quarter report that its exposure to United is \$1.2 billion, or about 10% of its total aircraft portfolio. Boeing Capital says its exposure to US Airways is "a very small fraction" and adds that it is "comfortable" with the United exposure, all of which is secured against aircraft.

Bombardier Capital says it has no exposure to either airline, although Bombardier Aerospace has limited exposure secured against regional

jets operated by United and US Airways Express. Bombardier Capital is working to liquidate its portfolio and hopes to raise \$5 billion, primarily through the sale and wind down of business aircraft financing.

■ Defaults on United Airlines debt, or a bankruptcy, are likely to make the capital markets even more difficult for its competitors. United faces \$900 million in debt payments between now and year-end, including a \$600 million public bond issue called the Enhanced Equipment Trust Certificate (EETC). An EETC finances aircraft and guarantees interest payments by a bank in the event of a default. Phillip Baggaley, airline analyst at Standard & Poor's, worries that companies that insure portions of EETC debt might withdraw if United defaults.

DISPUTE

USA to step up opposition to A380 launch aid

The US government plans "aggressive" opposition to the \$3.5 billion in European Union (EU)-backed loans to Airbus to support A380 development, says a senior government official.

Speaking in Brussels last week, US deputy secretary of commerce Samuel Bodman said the issue of A380 launch aid could be brought before the World Trade Organisation (WTO).

"The US government does not provide market financing to Boeing for the development of a specific product, and the European governments have decided to do that. I don't think that's fair," said Bodman. "We'll be quite aggressive about it in making our views known. The WTO would be one way to resolve it."

Under the 1992 EU/US large aircraft agreement, governments can provide manufacturers with loans on a commercial basis for up to 33% of the cost of developing a new airliner. Airbus's A380 development programme is estimated to cost \$11 billion. The Commerce Department declines to elaborate on what the USA believes is wrong with the loans.

In a recent WTO decision, the US government was found to have given US exporters, led by Boeing, massive illegal tax breaks. The ruling opened the way for the EU to impose \$4 billion in sanctions on US companies.

"This is a red herring brought about because Boeing is losing market share," says Airbus North America chairman Allan McArtor. "Rather than fix their own problems they would rather point the finger and say Airbus is out of bounds. This is a political issue with no substance."

McArtor says the A380 loans are "not subsidies" and "fall within the guidelines negotiated by the EU and the USA" in 1992.

PRIVATISATION

Cintra advised to postpone sell-offs



Mexican economic downturn has forced Cintra to postpone privatisation of Mexicana and Aeromexico

Cintra, the Mexican government-owned airline holding company, has delayed privatising Aeromexico and Mexicana on the advice of financial consultant Merrill Lynch. The Mexican economy has been hindered by its close links with the USA, meaning "the short-term conditions are not favourable for the sale", says Cintra.

The company has reported a net loss of 99 million pesos (\$9.9 million) for the third quarter, an

improvement on its 233 million pesos loss in 2001. Operating profit rose almost 25% to 202 million pesos. Revenues from the two carriers, plus their regional and cargo subsidiaries, fell by 4%.

This contrasts with airline performance in the USA's northern neighbour, with Air Canada reporting 6% higher revenues for the quarter and a net income of C\$125 million (\$80 million), a C\$1 billion improvement over the same period last year.

Unlike most of its North American counterparts, Air Canada expects a full-year profit.

Air Canada chief executive Robert Milton attributes the return to profitability to a market segmentation strategy and increased focus on low-cost operations. The Tango low-fare, long-haul sub-brand makes up over 19% of mainline traffic. Operating costs for Tango and no-frills subsidiary Zip are 25% lower than for mainline flights, Milton says.

RESULTS DAVID LEARMOUNT / LONDON

ATS providers count the cost of terrorist attacks

Traffic fall blamed for losses, while industrial unrest threatens more gloom

Three autonomous air traffic service (ATS) providers – Nav Canada, Germany's DFS and the UK's National Air Traffic Services (NATS) – have declared losses following the drop in traffic after last year's US terrorist attacks. Industrial unrest also threatens DFS and Nav Canada.

Nav Canada has declared revenue of C\$875 million (\$561 million) – C\$145 million below forecasts – in the year to 31 August. It expects traffic and revenue to stay below pre-11 September levels in the 2002/03 fiscal year, when it predicts a revenue shortfall of C\$80 million despite a 3% fee increase. Among the losses was C\$7.3 million owed by bankrupt charter carrier Canada 3000. Nav Canada says

it remains nervous about the prospect of bankruptcy for several large customers, such as United Airlines.

For the first three quarters of its current financial year, DFS is €57 million (\$56 million) below projected revenue, although it says monthly earnings are better than early in the year. Traffic is down 4.8%, and Lufthansa's move to smaller aircraft has lowered its ATS bill. DFS faces a demand for a 10% wage rise from operational workers, including the newly independent air traffic controllers' union.

Part-privatised NATS has declared an operating loss of £30 million (\$47 million) in the year to March 2002. It projects a revenue

shortfall of £230 million over the next five years. It suffered in particular from a 15% drop in North Atlantic traffic, which has traditionally brought in 45% of the company's revenue because the aircraft, on average, are heavier and pay more. NATS plans to cut its costs by £170 million by 2005, and is awaiting an expected relaxation of its price-capping mechanism and a capital injection of £130 million, split 50/50 between the government and airports group BAA.

With many ATS providers being government-run, it is not possible to compare results with neighbouring providers, in France and the USA for example, because accounting procedures do not show them.

LITIGATION

BAE briefs defence against fraud charge

BAE Systems is preparing to defend itself against accusations of conspiracy to defraud an Italian investor group of £6 million (\$9.3 million) over its involvement with collapsed British Airways franchise operator National Jet Italia.

In a claim lodged with the High Court in London, Italian finance house ABM alleges that BAE and Aviation Partners Worldwide (APW, formerly Tolmount), the latter owned by the late Peter Sutch, former Cathay Pacific chief executive, conspired to mislead it over APW's acquisition in July 2001 of National Jet Italia.

Both defendants have said they will oppose the charges, but have declined to comment any further.

ABM says that it agreed to invest £6 million in APW to give it the cash to buy National Jet Italia, but only if another investor was found to provide another £7 million. BAE, it alleges, put up this money, but only on the basis that it would receive the money back from National Jet Italia after the takeover, as a deposit on four regional jets which the airline would buy at an inflated price.

The takeover went ahead; BAE received its deposit; and the airline, hit by a cash shortage and the post-11 September crisis, ceased operations last November, after being sold for £575,000 – a fraction of the £30 million that was paid for it earlier that year.

ACQUISITION

ATK buys seeker specialist's assets

US munitions manufacturer Alliant Techsystems (ATK) has acquired the assets of Science and Applied Technology (SAT), a small missile seeker specialist. The deal will strengthen ATK's precision-guided weapons capability and position the company to become a missile prime contractor.

The acquisition could also safeguard the US Navy's decade-long programme to develop a successor to the AGM-88 high-speed anti-radiation missile (HARM), which has been threatened by the indictment of the owner of privately held SAT for alleged illegal political

contributions. ATK says it is acquiring only the assets of the San Diego-based company, and has no liabilities linked to the charges brought against SAT's founder, Parthasarathi Majumder.

SAT has worked on the Advanced Anti-Radiation Guided Missile (AARGM) technology demonstration since 1990 and has received over \$130 million in US Navy funding. The programme adds a terminal seeker to the HARM's radar-homing sensor to give a hard kill capability against non-emitting air defence systems. AARGM is to enter development next year.

The same multi-sensor seeker will be used in the US Navy's High-Speed Anti-radiation Demonstration programme. ATK's purchase of SAT's assets may remove the need for the US Navy to take contractual action that would harm both programmes.

SAT, with annual sales of \$40 million, will be renamed ATK Missile Systems and be part of the company's Precision Systems group. ATK, which will have sales of around \$2.1 billion in 2003, produces ammunition and precision munitions, rocket motors and composite structures.

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ALLIANCES

EC approves partnerships

European regulators have approved partnerships between European and US members of the Wings and Star Alliance airline groupings after a four-year investigation. The European Commission's (EC) investigation of SkyTeam continues.

The EC closed its study into alliances between Star members Lufthansa, Scandinavian Airlines and United Airlines, and Wings members KLM and Northwest Airlines last week.

It suggests it "will apply a similar approach" when investigating SkyTeam's Air France, Alitalia and Delta Air Lines.

The investigation into Star members was opened by the EC in 1998, concerned that the partners controlled 56-95% of the market from Frankfurt to Chicago, Los Angeles, San Francisco and Washington DC. However, the parties have offered to surrender slots on the routes and agreed that new entrants using the slots and operating a non-stop service will be admitted to the Star Alliance frequent-flyer programme and will be offered interlining facilities.

EU concerns about the KLM/Northwest Airline Wings alliance centred on the 88% share held on the Amsterdam-Detroit route and 78% on the Amsterdam-Minneapolis/St Paul route. But the EC says there were "no structural barriers to entry in terms of slot constraints or regulatory barriers".

DELIVERIES GRAHAM WARWICK / WASHINGTON DC

No end in sight for business and light aircraft downturn

Only Cirrus bucks trend as manufacturers struggle to meet year-end delivery forecasts

Business and light aircraft shipments continued their decline in the third quarter, and some manufacturers face a challenge meeting their year-end delivery forecasts. Worldwide shipments have fallen almost 17% in the first nine months, to under 1,800 aircraft, according to the General Aviation Manufacturers Association (GAMA).

Turboprops continue to be the hardest hit, deliveries falling 26% in the third quarter and by over 40% to just 170 aircraft in the first nine months. Jet shipments declined by 15% for the quarter and, at 497 aircraft, are 12% down for the year to date. Piston aircraft deliveries were down 8% for the quarter, and by over 14% to 1,099 aircraft in the first nine months.

Only Cirrus Design bucked the downward trend, shipping 119 light aircraft in the third quarter, up from 43 a year ago as it ramps up production and works off its backlog.

Cessna's orderbook has been boosted by launch sales for 217 entry-level Citation Mustangs and 156 CJ3 light jets, but deliveries of these aircraft will not begin until 2004 and 2006, respectively.

With demand for business jet deliveries in 2003 and 2004 down 15% from this year, Cessna is slowing Citation production. The company says all 300 aircraft scheduled for shipment this year are now sold, while orders have been taken for around 70% of the 250 planned for delivery next year.

Raytheon Aircraft says over half

its deliveries scheduled for the fourth quarter, 65 out of 123, were unsold at the end of the third quarter. These included 24 King Air turboprops, 12 Hawker 800XP mid-size jets, eight Beechjet 400A and five Premier I light jets, but the company is "guardedly optimistic" about meeting its year-end forecast.

Raytheon has cut production this year to 282 aircraft, down from 378 last year, and again next year, to 276 units. Hawker production will rise from 39 to 46 aircraft, and from 33 to 58 for the Premier, but Beechjet, King Air and piston output will all be cut further and no Beech 1900D regional turboprops will be built.

Gulfstream's third quarter shipments dropped significantly from a year ago, with deliveries falling by seven to 17 for "green" aircraft and by five to 19 for completed business jets. It has "very few" open delivery slots left for this year, but "needs to sell some G200s by the end of the year", says parent company General Dynamics.

Bombardier has already said it is suspending business jet production for around four months, and Dassault is to reduce Falcon production from six to five a month, delivering 60 in 2003, down from the 72 planned for this year. The French manufacturer says it booked orders for 75 jets in the first nine months of the year.



Bombardier is suspending business jet production for four months

GOVERNMENT SUPPORT

IATA's Bisignani backs US security subsidies

The US government's plans to give its airlines more cash to cope with increased security measures have drawn flak from the European Union, but Giovanni Bisignani, chief executive of the International Air Transport Association (IATA), is supporting the US Congress action.

"We are not prepared to take the responsibility of paying for what governments should pay for themselves," Bisignani says. "Security

is the responsibility of the state."

As well as the direct costs, Bisignani complains, airlines are losing \$2.5 billion a year in "hassle costs" because intrusive security procedures discourage passengers on short-haul flights.

But he admits US subsidies are not entirely welcome. The USA is unwilling to support the International Civil Aviation Organisation's proposed Equitime insur-

ance plan because it is already giving subsidised war-risk coverage to US airlines. Although Bisignani describes the 40% support achieved so far as "an incredible positive result", the plan needs 51% backing if it is to get under way next February.

"European governments must continue to support their airlines for the next few months," he says. The European Commission re-

cently ordered EU member states to remove emergency insurance cover by the end of October. Several countries - including Finland, the Netherlands, Spain and the UK - are ready to cut their airlines loose (*Flight International*, 1-7 October), but Germany plans to appeal against the decision.

The move has worried IATA, as insurance premiums have soared to \$6 billion this year from \$1 billion.



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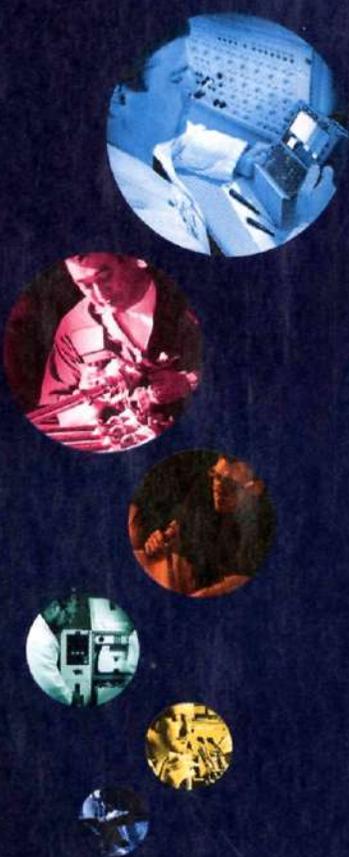
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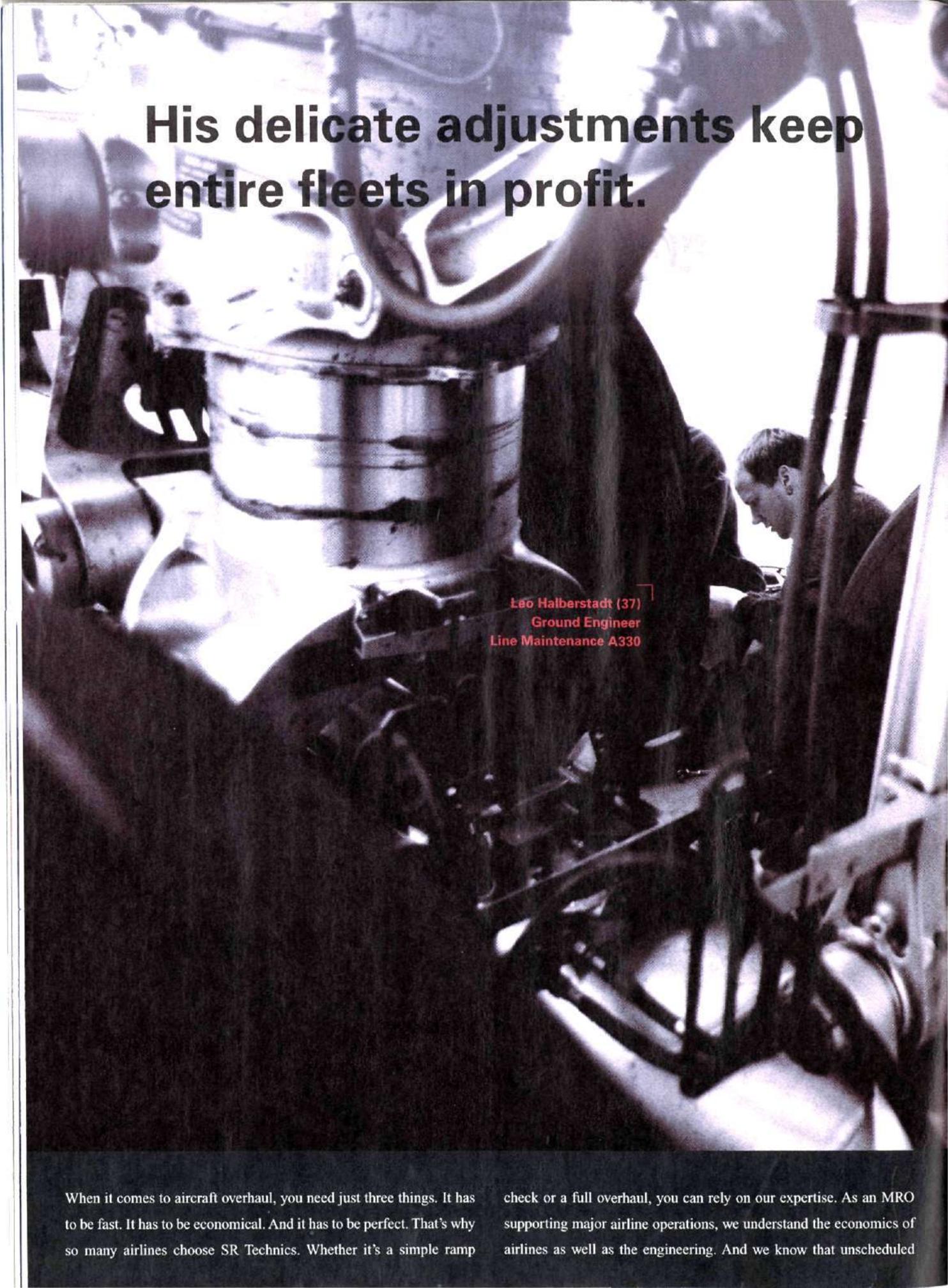
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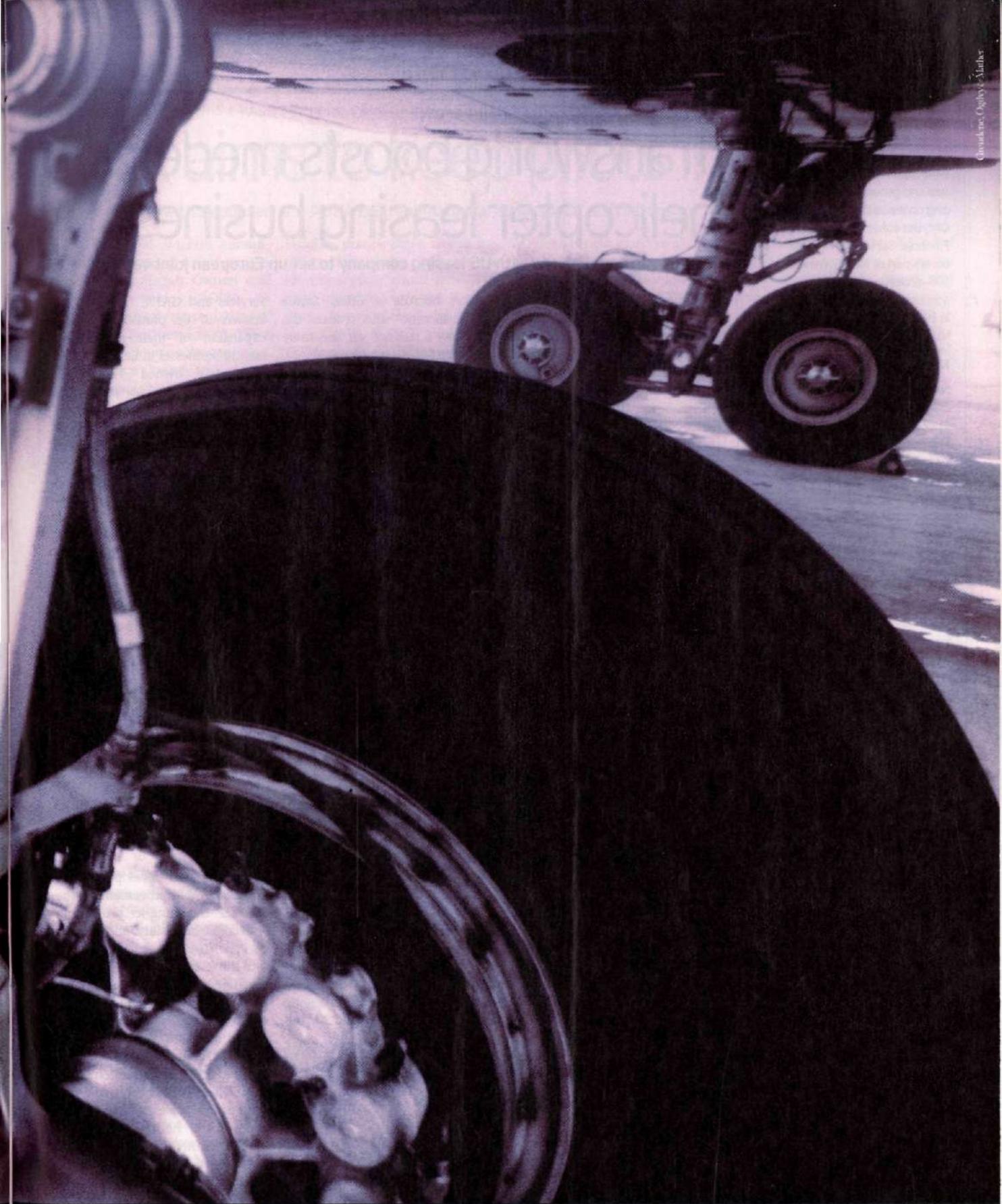
A black and white photograph showing a close-up of an aircraft engine. A ground engineer, Leo Halberstadt, is visible in the background, focused on his work. The engine's complex structure, including various pipes, valves, and components, is the central focus of the image. The lighting is dramatic, highlighting the metallic surfaces of the engine.

**His delicate adjustments keep
entire fleets in profit.**

Leo Halberstadt (37)
Ground Engineer
Line Maintenance A330

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GE EXPANDS

GE Commercial Equipment Financing (CEF) is to acquire a \$448 million portfolio of corporate and general aviation financing contracts from Daimler-Chrysler subsidiary debis Financial Services. The deal covers part of the \$800 million, 300-aircraft portfolio debis acquired from Raytheon Aircraft in 2000. The rest is up for sale, says debis.

NIMBUS BUY IS OFF

Nimbus Group has terminated a letter of intent to purchase Florida-based charter and fractional operator Horizons Aviation – signed after Eclipse Aviation terminated Nimbus's 1,000-aircraft order for Eclipse 500 personal jets for failing to raise the deposit – but still plans to set up a nationwide air-taxi service.

ACJ APPROVAL

The Airbus Corporate Jetliner (ACJ) has received US approval for scheduled service and private operation, paving the way for North American deliveries.

EXPANSION ANDREW DOYLE / SINGAPORE

Transworld boosts medevac helicopter leasing business

Company in negotiations with US leasing company to set up European joint venture

Australia-based TransWorld Aviation Group is aggressively expanding its nascent European helicopter leasing business and aims to build up a portfolio of 30 medevac aircraft by the end of 2003.

Paris-headquartered TransWorld Helicopter Leasing, a unit of the company's European fixed-wing leasing business, has already placed two pre-owned Eurocopter AS355Ns with French operator Aerosystèmes Heliocéan Hélicoptères for five years and an AS350 with Jet Systems for three years. The company is also finalising a deal to place four Agusta A109s in Italy.

Group managing director Tony Griffin says the company is moving into the European government-funded medevac helicopter leasing

market because it offers "more secure income" and reduces the company's reliance on the more cyclical fixed-wing business.

The company specialises in taking over purchase contracts already negotiated by the operator.

"There appears to be a good gap in the market," says Griffin. "Helicopters also hold a high resale value relative to fixed-wing aircraft." He estimates the European market has the capacity to absorb up to 100 leased medevac helicopters a year, but only a handful of players are active in the market.

"We are negotiating with one of the major US leasing companies with a view to expanding through a joint venture," says Griffin, declining to name the company. General Electric Capital Aviation

Services and GATX, however, are known to be plotting a major expansion of their rotary-wing leasing businesses in Europe.

Privately owned TransWorld Aviation Group has fixed-wing leasing units in Australia, Europe and Singapore, which offer aircraft on operating lease ranging from 40-seat turboprops to Airbus and Boeing narrowbodies. TransWorld subsidiary, Luxembourg-based Eurojet Aircraft Leasing, focuses on regional jets. Griffin says helicopters should account for 20% of the group's annual leasing revenue by the end of 2003.

The company has also set up TransAustralian Air Express, which operates a fleet of Boeing 727 freighters on scheduled and charter flights.

DEVELOPMENT GUY NORRIS / PALM SPRINGS, CALIFORNIA

Cirrus delays diesel-powered SR22 variant

Cirrus Design has delayed plans to start delivering a diesel-powered variant of the SR22 from this year to mid-2003 as it focuses on more pressing priorities, such as the all-electric SR20. The company is discussing development alternatives with diesel engine maker SMA, which could include the EADS/Renault/Snecma joint venture leading the supplemental type-certification (STC) programme for the diesel-powered variant.

SMA, which has completed assembly of the first SR305 engine for Cirrus's proposed SR21tdi project, is developing the STC for the SR305-powered Cessna 182 and for EADS Socata. One option, says Cirrus, could be for SMA to do the STC on the SR21tdi.

"Basically, we are now a lot more comfortable that SMA has not only a certificated engine, but also an engine ready to go into production," says sales support director

Ian Bentley. "But it is a little unrealistic to think of deliveries by year-end, maybe it will be more like six to eight months from now."

Cirrus is fully occupied preparing to switch over production to the all-electric SR20 in January. As part of the switchover, it is developing more cost-effective production techniques, including larger production batches to reduce overheads when changing assembly between the SR20 and

SR22. A total of 60 SR20s will be produced in the first batch of 2003, for example, compared with five or 10 previously.

Cirrus is also developing more upgrades and improvements to the SR20/22, including ice protection, a datalink capability and a glass cockpit. "The SMA engine has to fit into the research and development schedule," says Bentley, who adds that the large order backlog also reduces the urgency.

Six hundred Cirrus aircraft have been delivered and the backlog is "around 350", says president Alan Klapmeier. "We hit the two a day [production] rate in July/August and we will hold that, or even lower it slightly through December. We expect to review that and maybe move it up to three a day in late 2003 when we expect the economic recovery to begin."

The 170kW (230hp) SMA SR305 diesel is also being developed for the MX-9-230, a derivative of the Maule Air M-7 five-seat light aircraft.



Cirrus hopes to raise production rates to three a day in late 2003, when it expects economic recovery

SECURITY GUY NORRIS / PALM SPRINGS, CALIFORNIA

FAA aims to keep pilots informed

Collaboration with Jeppesen and AOPA is intended to clarify airspace restrictions for pilots post-11 September

The US Federal Aviation Administration is working with Jeppesen and the US Aircraft Owners and Pilots Association (AOPA) to develop graphical representations of temporary flight restrictions (TFRs) in a bid to eliminate the confusion over airspace closures that general aviation pilots have faced since the September 2001 terrorist attacks.

Newly appointed FAA administrator Marion Blakey admitted at the AOPA Expo, which took place in Palm Springs, California, in late

October, that its flight service stations (FSS) have not always informed pilots about new TFRs along intended routes and, in some cases, have released inaccurate information. AOPA is pressing for TFR data to be available to all pilots.

Working with Jeppesen, the agency is developing graphical depictions of TFRs to superimpose on aeronautical charts. "We are deploying it to flight service stations and we plan to make it available to the pilot community and

AOPA early next year," says Blakey.

AOPA president Phil Boyer says, however, that the real solution lies in making the graphical TFR capability available to all pilots, not just through the FAA stations. "Hopefully that will happen sooner rather than later," he says, adding that written Notams about the restrictions are difficult to interpret. AOPA has added graphical TFR depictions to its Flight Explorer Personal Edition real-time aircraft tracking service, which tracks all instrument

flight rules aircraft in the USA in real time, showing position, origin and destination, altitude, speed and other data. But Boyer is concerned the AOPA system would be liable in the case of any mistake in TFRs, unlike a potential FAA-based system.

Meanwhile, Jeppesen says it is awaiting FAA clearance on already developed software allowing pilots to view TFRs on a website or to adapt existing flight planning systems that will recognise the TFRs and reroute aircraft around them.

RECOVERY

Mystery investor sparks all-electric Lancair Columbia 350 back to life

Oregon-based Lancair plans to certify the all-electric Columbia 350 next January after securing new funding from a mystery investor to restart operations.

The company shut down in July, but Lancair president Bing Lantis says it will resume operations this month. Although the company had hoped to announce details of the new investment at AOPA, it was unable to do so "because not everything is signed", says Lantis.

Although an undisclosed share of the company was sold as part of the deal with the new investor, which now holds a controlling stake, Lantis says: "They are aviation people and they want the company to succeed."



Lancair's 56 in-service 300s could be joined next year by 350s and 400s

The follow-on full authority digital engine control (FADEC)-equipped Columbia 400 is expected to be certificated in April and has already accumulated

around 1,000h of testing, says Lantis. Lancair has a firm backlog of 180 aircraft, including several ordered during AOPA.

"We've taken 20 deposits since Oshkosh [in July]," adds Lantis, who says interest in the Columbia family has remained high. The backlog is divided evenly between 300 and 400 versions, although the latest order preference is roughly two-to-one in favour of the 400. There are 56 300s in service.

Some 99% of former Lancair employees are likely to rejoin the company, which is aiming for a rate of 10 aircraft a month to break even.

Future potential includes variants with retractable undercarriage, pressurisation, alternative piston engines and a turboprop derivative.

SALES

Mustang stampede runs on

Cessna's newly launched Mustang personal jet is expected to reach the 300th sale milestone early this month, having attracted more business at AOPA Expo than expected.

Cessna president Russ Meyer says: "The rather amazing response to the Mustang at NBAA [National Business Aviation Association show in September] might indicate that we have underestimated the size of this market."

He adds: "We will be well into production four years from now, and we are planning a rate of at least 150 to 200 a year." The company plans a 12h line move, with one Mustang to leave the factory every day-and-a-half.

Selection of a 1,350lb-thrust (6kN) engine between Pratt & Whitney Canada's PW600F and Williams' FJ series is expected "within 90 days", says Cessna, and the avionics package will be defined in the first quarter of next year.

The Mustang is aimed at the owner-flown market, to replace piston twins and turboprops. Competing aircraft include the EADS Socata TBM700 and Beechcraft King Air C90 single and twin-turboprops.

CERTIFICATION

Liberty prepares for spin

Liberty Aerospace expects to achieve certification by April of the XL-2, pending successful flight tests, including spin tests.

Approval was planned for mid-2002, but has been delayed, says Florida-based Liberty, by its decision to reconfigure the two-seat aircraft with a larger 105 litre (28 USgal) fuel tank and the Powerlink FADEC (full authority digital engine control) version of the 96kW (125hp) Teledyne Continental IOF-240 piston engine. "We have 60 firm deposits and around 120 further aircraft are in the sales process," says sales and marketing vice-president Kenneth Starnes.

Meanwhile, the aircraft is into the second week of a planned 60 days of flight testing and, when the tests are completed in January, the XL-2 is expected to become the first single-engined piston to be certificated with a FADEC, narrowly beating the similarly equipped Lancair Columbia 400.

DIRECTED ENERGY GRAHAM WARWICK / WASHINGTON DC

Weapons-grade lasers on horizon

Breakthroughs in solid-state technology promise airborne munitions that could defeat missiles by end of the decade

Raytheon believes solid-state laser technology has matured to a point where directed-energy weapons suitable for installation on aircraft could be available by the end of the decade.

The company is competing against TRW and others to demonstrate a 25kW laser in the laboratory as a step toward developing a 100kW weapon-grade laser.

Breakthroughs in the last decade have made solid-state laser weapons viable, says programme manager Chan McKearn. These include high-brightness diode-pumped slab

lasers using materials that generate less heat, and architectures producing a high-quality beam that puts more energy on the target.

McKearn says Raytheon is working on solid-state lasers, based on ytterbium (Yb), which generate a quarter of the heat produced by neodymium-based lasers. Its architecture uses high-power Yb:YAG slab lasers to amplify a high-quality, low-power beam produced by a master oscillator. A phase-conjugate mirror removes aberrations caused by the amplifiers, producing a tightly focused beam, he says.

Raytheon has demonstrated a 2.6kW solid-state laser in the laboratory and is competing to build a 25kW device for the US Air Force Research Laboratory (*Flight International*, 1-7 October).

Bench tests of the 25kW laser are planned for 2004-05. The tests could lead to a 100kW weapon-grade laser being available by the end of the decade, says Michael Booen, vice-president directed-energy weapons at Raytheon Missile Systems.

A likely initial use of directed-energy weapons will be to defend

aircraft against missile attack. Although a 25kW laser could be enough to damage the seeker on an infrared-guided missile, a 100kW weapon will be needed to defeat radar-guided missiles at useful ranges, says Booen. Other potential uses include surgical attacks in urban areas. "Directed energy is the future of precision strike," he says.

Early candidates for laser weapons include the Lockheed Martin F-35 Joint Strike Fighter, as well as gunships and unmanned combat air vehicles.



UNIVERSITY OF QUEENSLAND

July test demonstrated successful supersonic combustion

SCRAMJET PETER LA FRANCHI / BRISBANE

HyShot tests need funding

The University of Queensland is planning 10 more scramjet engine test flights over the next five years to determine whether the technology is viable in a commercially usable propulsion system for launch vehicles.

However, A\$80 million (\$44.25 million) is required to continue the programme, with backers being sought. Dr Allan Paull, director of the University of Queensland research programme, says at least A\$25 million is required to ensure basic research continues, with existing funding exhausted after the HyShot trials in October 2001 and July this year.

Paull says the five-year research push is needed to get scramjet technology ready for commercial exploitation. "There are aspects of scramjet flight we don't fully understand yet, and there has been no testing done," he says. "We don't know how to accelerate between the Mach number range of eight and 15. We don't even know if they will operate at 15."

Paull says if the full A\$80 million funding is secured, the next scramjet test flight would take place in late 2003, with three flights following in 2004 and at least one in 2005. The 2003 flight would attempt to demonstrate net energy gain, following the demonstration of supersonic combustion in the July HyShot flight. That engine had all thrust surfaces removed. "We couldn't have controlled it if we had thrust surfaces," says Paull.

The tenth flight would seek to demonstrate flight control of a scramjet engine, including level hypersonic flight under power.

SAFETY

A380 to get diagnostic fire-detection system

Meggitt Safety Systems has developed an engine fire-detection system that is also a diagnostic engineering tool – and has been selected by Airbus for the A380. The device can identify the precise location of fire, smoke or heat in an engine rather than just identifying which engine has the problem.

California-based Meggitt supplies conventional fire-detection systems for existing Airbus types. The new equipment is based on a controller area network (CAN) for each engine, which is a unit linked to multiple sensors that can pinpoint which of the sensors has detected heat, and store the information. Airbus refers to it as a diagnostic zone technique, and says it

will be a maintenance aid in detecting problems before they become serious. Meggitt says there will be five-sensor CANs for each engine in Rolls-Royce-powered A380s, three-sensor units in the Engine Alliance power units, eight-sensor CANs in the landing gear, and two-sensor units in the auxiliary power unit.

Airbus says there are more supplier and system decisions yet to be made for the complex A380 fire detection system, but it is enthusiastic about the diagnostic zone principle. Meggitt says its first A380 CAN systems will be delivered next August for mounting in the "iron bird" test rig. Meanwhile, Airbus is using CAN modules in the A318 smoke detection system.

SPACECRAFT

Devils aims for commonality

The European Space Agency (ESA) and six European space companies – Astrium, Alcatel Space, Alenia Spazio, Contraves, Dutch Space and Saab Ericsson – have launched a €50 million (\$49 million) initiative to encourage the building of common, intelligent lightweight spacecraft systems that can be plugged into several types of craft. The "off-the-peg" initiative, called Devils – develop intelligent lightweight spacecraft – follows the use of common components on ESA's Integral, Mars Express, Newton, Rosetta and Venus Express missions. The first use of Devils is likely to be the Bepi Colombo Mercury mission.

PROPULSION GRAHAM WARWICK / WASHINGTON DC

Engine projects halted as NASA turns to kerosene

Development work to focus on reducing risk from hydrocarbon-fuelled powerplants

Boeing's Rocketdyne division is winding down work on its RS-83 reusable cryogenic rocket engine, as NASA focuses on kerosene-fuelled powerplants under its Space Launch Initiative (SLI) to develop technology for a second-generation reusable launch vehicle (RLV).

NASA has already ordered Pratt & Whitney and partner Aerojet to halt work on the Cobra cryogenic reusable engine. Work on the rival RS-83 will stop by year-end, says Rocketdyne SLI programme director John Vilja. The company will continue development of the RS-84, one of two kerosene-fuelled rocket engines being funded by NASA. TRW, meanwhile, is working on the kerosene-fuelled TR107.

Vilja says NASA's decision to stop work on liquid-hydrogen/liquid-oxygen engines is a result of an

assessment "that the risk level with reusable high-power kerosene engines is higher, and that it is better to focus on the area where they get the most risk reduction". NASA plans to ground-test at least one prototype engine before making a decision in 2006 on whether to proceed into full-scale development of a second-generation RLV.

While hydrogen engine tests were planned for 2005, prototype kerosene engine tests are not scheduled until the first half of 2006. "That allows NASA to take a year off [from hydrogen engine development] and still meet the 2006 decision date," says Vilja. The space agency could restart cryogenic engine work in a year and still meet its deadline, although a decision on developing a second-generation RLV is almost certain to be delayed.

Rocketdyne's RS-84 is a 1.05 million lb thrust (4,700kN) staged-combustion rocket engine, which evolved from work on high-power kerosene engines for the stillborn Space Shuttle liquid fly-back booster.

Under this programme, Vilja says, the company conducted small-scale tests of turbine materials that could operate in an oxidiser-rich environment without coatings, improving reusability. That work is now being scaled up.

NASA, meanwhile, has delayed an SLI system requirements review set for this month. The agency is expected to divert funds from a second-generation RLV to development of an orbital spaceplane that can be launched on an expendable booster to provide crew rescue for the International Space Station.

INTERNATIONAL SPACE STATION

Fresh construction crew readied

Ten new crew members are scheduled to fly the International Space Station (ISS) over the course of this month to undertake the next phase of construction.

The first Soyuz TM-A spacecraft was launched on 30 October aboard a Soyuz FG booster from Baikonur, Kazakhstan, carrying a three-man crew that will stay at the station until 9 November, when they will return to Earth in the Soyuz TM 34 launched in April.

Space Shuttle *Endeavour* is due to follow on 10 November on mission STS 113, carrying four flight crew and the three Expedition Crew 6 members who will replace Crew 5. The latter will return aboard the Shuttle, ending a mission that started in June, while Expedition Crew 6 will remain in space until next March.

The STS 113 crew will install the P1 solar array truss segment on the port side of the central S0 truss,



Three spacewalks will be required for work on the ISS this month

which was attached to the ISS Destiny module in April, and the starboard segment, the S1, which was installed last month. The S1 and P1 segments contain the station's primary cooling system, including pumps and piping and three large radiator panels. Heat generated by the station's electrical systems is transferred from internal

water loops to external ammonia lines in heat exchangers and routed to the S1 and P1 radiator panels.

Connecting electrical cables, data lines and ammonia fluid jumpers will require three spacewalks. The spacewalkers will also install a second "railcar" for the Canadian mobile transporter.

OPTICAL CONTRACT

NASA has awarded a contract, potentially worth \$28.4 million, to Ball Aerospace and Technology to develop the optics and detectors for a high-technology camera on the Kepler planet-hunter spacecraft to be launched in 2007. Eastman Kodak will provide the optical subsystem under a \$4.5 million contract. The camera will provide an extremely wide field-of-view, allowing Kepler to gaze continuously at more than 100,000 stars simultaneously. Almost 100 suspected planets have already been detected orbiting other stars using Earthbound telescopes.

POWER LOSS

Services from the Anik F1 satellite could be affected as early as 2005 due to a loss of power caused by a generation problem. Anik F1 is one of six Boeing 702 spacecraft in orbit that incorporate a defective solar array system and are losing power more rapidly than expected. The problem, which has been fixed on new 702 spacecraft, involves fogging of solar-array concentrator panels. Other satellites affected are the two XM Radio satellites, Panamsat's Galaxy 11 and PAS 1R and the 702-derived Thuraya 1 spacecraft.

ANOTHER STAR

Orbital Sciences has been awarded a \$73 million contract to build Indonesian PT Telkom's new regional communications satellite to be launched in 2004 to replace Palapa B4. The spacecraft will be based on Orbital's Star 2 small geostationary communications spacecraft bus and will carry 24 C-band transponders.

INVESTIGATION

French minister for research, former astronaut Claudie Haignere, will lead a commission to investigate the national space agency CNES after a vote of no confidence by the majority of the staff in the agency's president, Alain Bensoussan. The French government has already cut CNES's 2003 budget.

BOXING CLEVER

Airport-in-a-Box, a computerised information system, has transformed operations at Mexican airports and is set for more American success

KAREN WALKER / CANCÚN

A passenger waiting at Mexico's Cancún Airport can now enjoy a leisurely coffee or margarita while monitoring the status of his flight – the simple things in life best illustrating the difference information technology can bring to air transport.

A couple of years ago, a coffee or margarita stop was difficult to fit in because the passenger had no way of also keeping an eye on his flight – whether it was still scheduled to depart on time, delayed, or if there had been any gate changes. Such information was only available at the gate.

That and more changed at Cancún when privatised Mexican airport authority ASUR began a major upgrade and became the launch customer in the Americas for Sita's airport operations IT system, known as Airport-in-a-Box.

By allowing real-time flight information to be displayed on monitors throughout the airport, including in bars, restaurants and duty-free shops so that passengers are free to spend more time – and money – at Cancún's facilities, Airport-in-a-Box is not just a service improvement for customers, but also a revenue booster for ASUR.

The authority, which has so far invested \$10 million in IT to improve the efficiency of Cancún, is now taking the concept to a group level, hooking up the Airport-in-a-Box system installed at Cancún to its other

airports in Cozumel, Huatulco, Mérida, Minatitlán, Oaxaca, Tapachula, Veracruz and Villahermosa.

Airport-in-a-Box links all the data and information gathered by an airport so that it can be shared across the system, allowing such items as automated billing of airlines and real-time flight and gate information for passengers.

Network extension

Over the next year, and working under a \$4 million follow-on contract from ASUR, Sita will extend the system to the other eight airports, with Cancún remaining the IT hub. By extending the network to all nine of its airports, ASUR additionally will gain a constant overall picture of the group's operations and finances from its Mexico City headquarters.

ASUR chief administrative and financial officer Adolfo Castro says that, since the system was installed, Cancún has seen billing complaints from airlines fall 30-fold – itself another customer service improvement, but also a cost saving as fewer bills need to be corrected and resubmitted. Castro is also confident of the revenue benefits over time. "For example, with the passenger information screens, people can now see if their flight is delayed and can have another cup of coffee at a restaurant. Before, they had to just sit and wait at the gate."

Castro says that, when ASUR set out two years ago to outline its needs for Cancún: "This airport was very different then. There were no information systems, no network, no cabling systems. Everything was very sparse and we had serious problems with counter capacity."

Cancún Airport has been growing 7.4% a year in line with the rapid increase in tourism in the area. The airport now serves 40 airlines – 29 of them international. But two years ago, all of its operations were being handled manually, including boarding pass distribution and airline billing.

The basic lack of any IT at Cancún was in some ways an advantage as the airport set out to transform its operations. Sita's Mexico, Central America and Caribbean representative Carlos Arto explains: "Sita had an opportunity, unique in the airport world, to start from scratch, and this happened at a time when Sita had integrated the technologies into one single solution."

That "single solution" approach was at the top of ASUR's wishlist. More than anything, the organisation was looking for a system that could first transform operations at Cancún, but which could then become the master centre for ASUR's other airports dotted around Mexico.

"That's how we came to Cancún with our Airport-in-a-Box solution – the first sale to a Latin American customer," says Arto. "ASUR had a visionary approach. They wanted one infrastructure to serve all systems. They also had a number of systems that they needed to work together."

These include Sita's check-in system, CUTE, which is linked to the flight-information display system. Among the benefits of this automated check-in system is the ability to process passengers through the airport more quickly. With a faster check-in, there are shorter lines and less demand on limited space in this area of the airport. Passengers also can be given accurate, up-to-date information on their flights as they check in. Passport readers are installed in most check-in desks, so that information can be scanned into the system ahead of a journey.

Billing of airlines – previously done manually – has also become automated and more accurate. ASUR admits that before-and-after comparisons are difficult because previously the authority had no way of measuring the airport's performance in such areas. But now it can track 99.99% of the bills it sends out with complete accuracy. "Our revenues are much better controlled than they were before," says Castro.

Brazil's Infraero airport authority is set to be the next Americas' customer for Airport-in-a-Box. In October, Infraero announced it was awarding Sita a \$1.2 million contract to install the solutions at Brasilia Airport.

"These new state-of-the-art systems will enable us to maintain our rate of passenger growth in the most efficient and customer-friendly manner"

WAGNER MUSSATO, BRASILIA AIRPORT



Those solutions, which tie together to make up the "Box" package, will include Sita's AirportCentral operations and management database, AirportVision information display system, and AirportResourceManager automatic scheduling and allocation system for key airport equipment.

Passenger growth

Like Cancun, Brasilia Airport is seeing fast growth, with passenger throughput increasing 18% last year to nearly 7 million. "These new state-of-the-art systems will enable us to maintain our rate of passenger growth in the most efficient and customer-friendly manner," says airport assistant operations director Wagner Mussato.

Infraero controls Brazil's 67 largest airports and runs seven business centres. The privatised organisation says it has almost \$400 million earmarked for upgrade investments at several of its airports.

Sita's director of airport sales for the Americas Herve Muller explains the thinking behind Airport-in-a-Box: "The core of Airport-in-a-Box is the database. The idea is to have the right information at the right time. The core database captures all information in real time," he says.

"[Cancun] had isolated information systems that didn't talk to each other. Airport-in-a-Box centralises the information system. It was designed with a group in mind and was first implemented in South Africa with about 10 airports. Everything will be linked to the Cancun system. It gives central control to the whole group from its



headquarters in Mexico City. It gives them remote control over invoicing, and managing contracts with airlines."

Muller believes two factors drive airport authorities towards this IT investment. "They can better control their financial situation and they can make their airports more efficient in terms of how they process growing numbers of passengers," he says.

There are two more airport groups in Mexico – GACN and GAP – which each manage eight to 12 airports and are looking at the Sita system. Although their privatisation processes are not as far advanced as ASUR's, in which the government now holds only an 11% stake, their requirements would be similar.

Sita president, Dan Ebbinghaus says: "Airport-in-a-Box at its simplest is about integration. It helps airports become more efficient." He believes those efficiencies will become mandatory requirements as airports need to process

greater numbers of people while also meeting stricter security regulations.

Travellers, Ebbinghaus believes, will rebel "if they have to allow more than 3h to get through the check-in and security process at an airport – especially in the USA." So Sita is also working with several airport authorities on how IT can help, streamlining cross-border checks of passengers arriving at airports, providing baggage reconciliation technology or biometric identification systems for airport self-service check-in kiosks.

Sita has already secured major IT contracts from immigration authorities in Australia and Canada that allow government agencies to review passenger details ahead of arrival, making the immigration process swifter and easier. Low-risk passengers can be speeded through immigration, while officials can identify in advance those who need further checks or questioning. A major US airport has also signed up this year for a similar system. ■

With flight information available everywhere, passengers can pause for coffee at Cancun

DECISION SUPPORT LOCKHEED MARTIN

Creating a clearer picture

Better known for its air traffic control systems, Lockheed Martin is exploiting some of the same technologies to enter a new business area – information management systems for airlines and airports. "These tools bring benefit from the airline side," says Alan Bloodgood, director, communication, navigation and surveillance, at Lockheed Martin Air Traffic Management. "They consolidate data to provide better situational awareness."

The product suite includes real-time tools to help airlines and airports handle irregular operations and analysis tools to help users make better business decisions, says Bloodgood.

The hub and ramp management system is based on Lockheed Martin's SkyLine air traffic management (ATM) equipment in use in China, the UK and elsewhere. The system integrates air and ground surveillance data on to a single display at a hub airport, allowing the airline or airport operator to manage aircraft and vehicle ground operations. "They can see aircraft coming in and get a heads-up, which helps the airline manage its gates," says Bloodgood.

He adds: "The display provides an air and surface surveillance picture showing the status of aircraft and vehicles." The system can take in data from sensors such as radar, automatic dependent surveillance-broadcast, multilateration or TV cameras. "As the system is based off our international ATM product, it is robust and can take in a lot of feeds," he says.

An airline could put the system in place, or an airport authority, says Bloodgood. The information can be used by a specific carrier or provided to all airlines using an airport. The network allows up to 100 display positions and supports message interchange between airline users and with the air traffic service provider, enabling collaborative decision-making. "The system can export data via the web, to users such as icing trucks and baggage crews," he says.

The hub and ramp management system integrates with another Lockheed Martin decision-support tool, FitWinds. Using weather processing and forecasting technology

originally developed for the US Air Force and Navy, the flight and weather information and decision support system is intended for use in the airline operations centre. "It's mainly targeted at flight dispatchers to give them better situational awareness," says Bloodgood.

FitWinds takes aircraft position reports from FAA-supplied surveillance data and other sources and combines this with weather information to create a four-dimensional model of the atmosphere. The system is then able to interpret the interaction of the objects within the model: aircraft with airports and weather, and weather with airports

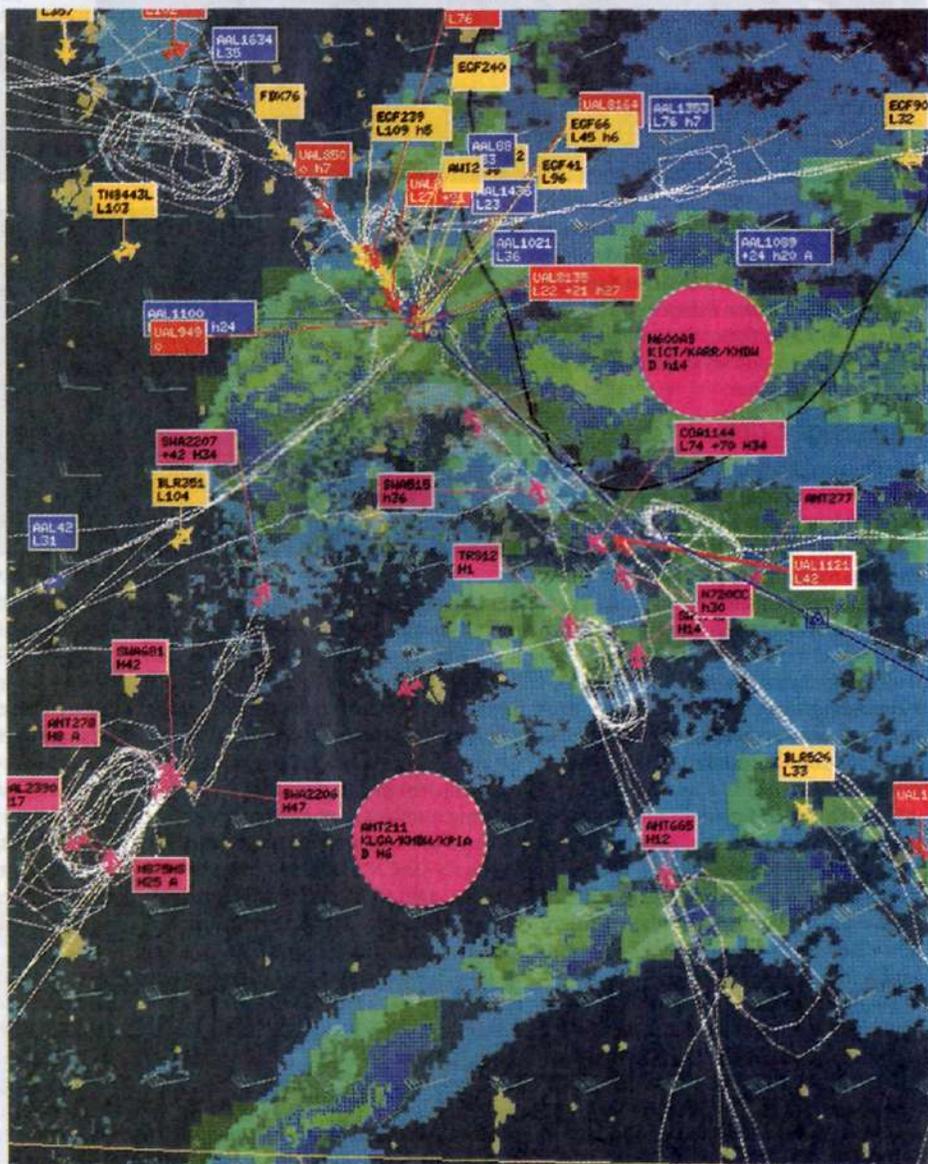
and airspace. FitWinds analyses flight plans and generates alerts for conflicts with hazardous weather or restricted airspace.

"Integrating the information on to a set of displays allows the user to track flights and do weather look-aheads so they can more efficiently manage the fleet," says Bloodgood. "When there is bad weather, FitWinds helps them look at the storm details and alternate routes so they plan a reroute, or maybe find a way through," he says.

An extension of FitWinds is the Spear system performance assessment tool. While FitWinds is an operational aid, Spear allows

airlines to perform business analyses. "FitWinds provides real-time tracking and analysis and collects a lot of airline-specific data. Spear is used to mine that data so the airline can do business analyses on or off line," says Bloodgood.

Reports can be generated automatically on hub airport departure and arrival performance; flight deviations and delays; city-pair performance comparisons; and airspace occupancy for overflight accounting. "This goes way beyond flight tracking," says Bloodgood. "With one mouse click, users can get data that today requires two or three different systems."



FitWinds generates a four-dimensional model of airspace, including aircraft and airports

DECISION TIME

With Airbus's A380 on track, Boeing needs to make up its mind about the Sonic Cruiser

MAX KINGSLEY-JONES / LONDON

Industry talk during the past 12 months has centred upon the prospects of Boeing sorting out its product development strategy as Airbus goes full speed ahead with the design and manufacturing of its giant A380.

Boeing's main preoccupation has been the effort to get the Sonic Cruiser and a new 747 variant off the starting blocks.

But the sudden change in the airlines' priorities since 11 September, 2001, which came too late to hamper the launch of the A380, seems to have holed Boeing's plans below the waterline, and the US manufacturer appears to be struggling to summon the courage of its convictions to go ahead with its dramatic transonic airliner.

Most airlines, or those prepared to look that far ahead, want any next generation airliner to be cheaper to fly rather than faster, and have encouraged Boeing to redeploy the advanced technology promised for the Sonic Cruiser into a conventional design which will deliver a step change in operating costs. Boeing has been studying an all-new 250-seater, dubbed "Project Yellowstone", as a conventional reference design to the Sonic Cruiser. Meanwhile, the company's 747X studies, which are centred upon subtle changes to the baseline -400 to boost range and reduce noise, have so far failed to gain favour among the potential customers.

Boeing faces some difficult decisions in the coming months. It looks increasingly unlikely that it will decide to launch the Sonic Cruiser next year as originally planned, and many observers believe that the US manufacturer will need to find a clever public relations spin to

avoid public loss of face. Perhaps Yellowstone could be the answer.

Airbus has so far suffered no such problems with its A380 programme, having accumulated almost 100 orders for the aircraft and is on target for assembly to start in early 2004. Metal cutting began in Europe early this year and the massive production infrastructure has begun to take place at plants around Europe.

Despite the progress, the European manufacturer faces a major task in keeping the ambitious programme on time and on budget, given the experience with its latest developments, the A340-500/600. The first variant of the new family, the -600, entered service with Virgin Atlantic in August, but the programme has been subject to a series of delays.

Meanwhile, after the shock of Concorde's fiery crash in Paris in July 2000, the industry suffered another blow last November when an Airbus A300-600R crashed after its carbonfibre tailfin broke off when it flew through wake turbulence. The incident immediately raised questions over the use of composites in the construction of primary structures, but the investigation has so far failed to find a design or structural fault, and is focusing on crew actions.

The same month that the A300 crashed, Concorde returned to the skies with Air France and British Airways after over a year on the ground. The development, certification and installation of a major modifications developed by the manufacturers and operators in such a short time was recognised as a major achievement, given that fewer than 12 months earlier there were genuine concerns that the supersonic transport had flown its last passengers. ■

Directory: world airliners

KEY TO DATA TABLES

Flight International's annual World Airliner directory is published in two parts on consecutive weeks. This week's Part 1 comprises airliners with more than 100 seats. Part 2, published next week, comprises civil airliners/utility aircraft seating from 10-12 passengers to 100 passengers, or with equivalent cargo capacity (including members of families that seat slightly more than 100, ie, the Avro RJ100/RJ115). Two aircraft, the 737-600 and Airbus A318, appear in both editions of the directory as they straddle the regional and large aircraft markets.

The aircraft data tables, compiled by *Flight International's* sister on-line news and information service *Air Transport Intelligence* from, where possible, information supplied by the manufacturers, includes dimensions, operating weights, powerplants, operating performance and passenger accommodation.

All data, and the performance measures in particular, are intended only as a guide and must be interpreted with care. They should not be used for operational purposes.

Powerplant data includes engine manufacturer, type and variant with the nominal sea level/ISA static thrust or power of each (lb thrust or kW).

Performance data includes maximum and normal cruise speeds in knots and where applicable Mach number under ISA conditions. Maximum operating altitude is also provided. Field lengths for take-off and landing are for a typical mission under sea level ISA conditions. Take-off field lengths include the distance required to accelerate the aircraft to flying speed, reject the take-off and stop within the runway length remaining. Design range with pax/payload is the typical mission data with stated passenger or cargo load, published by manufacturers. Option range(s) data is for higher MTOW(s).

Accommodation Seating capacity is provided for typical one-, two- and three-class layouts as quoted by the manufacturer. In many cases, the one-class layout is also the exit limit.

Sales and in service figures are sourced from manufacturers and the Airclaims CASE database (+44 (0) 20 8897 1066) and are correct to October 2002.

Conversions

Except for altitude, which is quoted in feet, (1,000ft = 305m), speed, which is quoted in knots (1kt = 1.85km/h = 1.15mph), and jet engine thrust which is quoted in pounds (1lb = 0.00445kN); metric measure is used as follows: 1kW = 1.34hp (shp); 1m = 3.28ft; 1m² = 10.76ft²; 1m³ = 35.3ft³; 1kg = 2.2lb; 1 litre = 0.264 US gal = 0.22 Imp gal; 1km = 0.54nm. Some figures are rounded for ease of reading.

Abbreviations

APB Aviation Partners **Boeing ARIA** Aeroflot-Russian International Airlines **BA** British Airways **Bae** British Aerospace **CAA** UK Civil Aviation Authority **CFMI** CFM International **EA** GE/P&W Engine Alliance **EADS** European Aeronautic Defence and Space **EFIS** electronic flight instrumentation system **ETOPS** extended-range twinjet operations **FAA** US Federal Aviation Administration **FAR** US Federal Aviation Regulation **FCS** flight control system **FMS** flight management system **GE** General Electric **GECAS** GE Capital Aviation Services **GPS** global positioning system **IAE** International Aero Engines **IAI** Israel Aircraft Industries **ICAO** International Civil Aviation Organisation **ISA** international standard atmosphere **ILFC** International Lease Finance **JAA** European Joint Aviation Authorities **JAR** European Joint Aviation Requirement **LCD** liquid crystal display **MoU** memorandum of understanding **MTOW** maximum take-off weight **P&W** Pratt & Whitney **P&WC** Pratt & Whitney Canada **R-R** Rolls-Royce **STC** supplemental type certificate **TCAS** traffic alert and collision avoidance system.

AEROSPATIALE/BAE

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Concorde

The world's only supersonic transport returned to the skies commercially on 7 November, 2001 after a grounding which lasted for more than 14 months. The 12 Concorde operated by Air France and British Airways had been withdrawn from service following the crash of a French aircraft shortly after take-off from Paris Charles de Gaulle Airport on 25 July, 2000.

The crash investigation determined the disaster was caused by a complex chain of events which started with a single tyre failure. As a result, the aircraft's certificate of airworthiness was withdrawn the month after the accident. In conjunction with the authorities and the manufacturers, both airlines developed a modification programme and have progressively upgraded their fleets.

The core of the work involved the installation of Kevlar liners in the fuel tanks, designed to block the hole and limit flow to a safe rate should fuel begin to escape from the wing underside. Changes have also been made to wiring on the undercarriage legs, while new Michelin NZG radial tyres are more resistant to foreign object damage.

The tank liners increase unusable fuel by around 180kg and incur a 400kg weight penalty. The new Michelin tyres save around 160kg. A new interior, expected to be installed next year, saves another 360kg, so the aircraft's weight will end up being 140kg below the pre-modification level.

AEROSPATIALE /BAE CONCORDE

Length (m)	62.1
Wingspan (m)	25.56
Height (m)	11.4
Wing area (m ²)	358.25
Cabin width (m)	2.87
Max take-off weight (kg)	185,070
Max landing weight (kg)	111,130
Operating empty weight (kg)	78,700
Max zero fuel weight (kg)	92,080
Max payload (kg)	11,340
Powerplant	4 x 38,000lb
	R-R/Snecma Olympus 593
Standard fuel capacity (l)	117,020
Normal operating speed (kt)	430
Normal operating speed (Mach)	2
Max cruise speed (kt)	1,176
Max cruising altitude (ft)	62,000
Take-off field length (m) (sea level/ISA)	2,900
Landing field length (m) (sea level/ISA)	2,150
Accommodation (typical)	100
Design range with pax	6,200km/100

BA flew the first modified aircraft in July 2001 and the modifications received French and UK approval in September 2001, when the aircraft's certificate of airworthiness was restored.

The two airlines resumed daily services from London and Paris to New York last November. Four of Air France's five remaining Concorde are back in service. Work to upgrade the fifth is under way. BA has returned five of its seven aircraft to service and the sixth Concorde is undergoing modifications. A decision on the seventh aircraft has not yet been made.

A BA-led life-extension programme under way since the early 1990s resulted in airframe life being increased to 8,500 reference flights from the original 6,700 (a reference flight is a calculated using variables including take-off weight and flight duration). This is expected to keep the aircraft flying until around 2010-11, based on current operational projections. The Air France aircraft can remain in service until the same point with the original design limit, as these aircraft are operated on fewer flights than their BA counterparts.

Over the next four years BA will have to decide whether it wants to develop a second life-extension programme to extend the aircraft's flight limit to around 11,000. This would allow the fleet to keep flying until 2015.

While the 8,500-cycle clearance only required an increased level of inspections, any new limit is likely to require structural reworking, which will require greater investment.

Aerospatiale (now EADS) and British Aircraft Corporation (BAC) (now BAE Systems) jointly developed the Mach 2 airliner, which made its first flight from Toulouse in France in March 1969. Concorde entered service with Air France and BA in 1976.

Production

The aircraft were assembled on dual production lines in Filton and Toulouse. Of the 20 Concorde built, four were prototype/pre-production models and 16 were production examples, 14 of which were delivered to the two airlines.

Delivered: 14

In service: 12 (including three aircraft awaiting modifications)

AIRBUS A300

	B4-200	B4-200F	-600R	-600F	-600ST Beluga
Length (m)	53.75	53.75	54.1	54.1	56.158
Wingspan (m)	44.84	44.84	44.84	44.84	44.84
Height (m)	16.53	16.53	16.54	16.54	15.06
Wing area (m ²)	260	260	260	260	260
Cabin width (m)	5.28	5.28	5.28	5.28	7.4
Max take-off weight (kg)	165,000	165,000	170,500	165,100	155,000
MTOW option	-	-	-	170,500	-
Max landing weight (kg)	134,000	136,000	140,000	140,600	140,000
Operating empty weight (kg)	80,640	81,600	90,300	79,000	86,500
Max zero fuel weight (kg)	126,000	126,000	130,000	133,800	133,800
Max payload (kg)	35,500	44,400	39,700	54,700/51,000	47,300
Powerplant	2 x 52,350lb	2 x 52,350lb	2 x 61,340lb	2 x 61,340lb	2 x 58,870lb
	GE CF6-50C2	GE CF6-50C2	GE CF6-80C2A5	GE CF6-80C2A5	CF6-80C2A8
	or 2 x 53,000lb	-	or 2 x 57,750lb	or 2 x 57,750lb	-
	P&W JT9D-59A1	-	P&W PW4158	P&W PW4158	-
Standard fuel capacity (l)	62,000	62,000	68,150	68,150	62,000
Normal operating speed (kt)	298	298	325	325	295
Normal operating speed (Mach)	0.78	0.78	0.79	0.79	0.7
Max cruise speed (kt)	480	-	480	480	295
Max cruising altitude (ft)	35,000	35,000	40,000	40,000	35,000
Take-off field length (m, sea level/ISA)	-	2,850	-	2,280	1,950
Landing field length (m, sea level/ISA)	-	1,635	-	1,489	1,176
Accommodation (1-class)	345	-	361	-	-
Accommodation (2-class)	254	-	266	-	-
Accommodation (3-class)	-	-	228	-	-
Design range	5,270km/	4,350km/	7,700km/	4,350km/	2,700km/
with pax/payload	251	41*	266	54.7t	44.5t
Option/payload	-	-	-	6,290km/51t	-

Notes *80% volumetric payload

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Based in Toulouse, France, Airbus Industrie was formed to manage the development and marketing of the 250-seat A300B widebodied twinjet.

Airbus was created as a Groupement d'Inter Economique in December 1970 (a 50:50 joint venture between Aerospatiale and Deutsche Airbus, then part of MBB). Spain's CASA joined the consortium in 1971, followed by BAe (now BAE Systems) in 1979. The French and German partners each held 37.9%, CASA 4.2% and BAe 20%.

Following the creation of EADS in 2000, a restructuring of the consortium into the Airbus Integrated Company was undertaken which took effect in mid-2001. EADS holds 80% and BAE the remainder. Airbus is now described as an EADS joint company with BAE Systems. The original four partners Airbus companies are now wholly owned by Airbus, and designated Airbus España, Airbus France, Airbus Deutschland and Airbus UK.

A300

The first passenger A300s built for more than four years are being delivered this year to Japan Air System (JAS). In 2001 the airline ordered up to five -600Rs to replace its ageing A300B2/B4s.

The first Airbus to be launched was the 250-seat A300B in May 1969. The widebody twinjet made its first flight from Toulouse in October 1972. The first production A300 variant, the B2, entered service in

May 1974. The B4 growth-weight version followed, and several F4 and C4 versions were completed with maindeck cargo doors. Two slightly smaller B1s were built, only one of which was delivered.

AIRBUS A310

	-200	-200F	-300	-
300F				
Length (m)	46.66	46.66	46.66	46.66
Wingspan (m)	43.9	43.9	43.9	43.9
Height (m)	15.8	15.8	15.8	15.8
Wing area (m ²)	219	219	219	219
Cabin width (m)	5.28	5.28	5.28	5.28
Max take-off weight (kg)	142,000	142,000	164,000	164,000
Max landing weight (kg)	123,000	123,000	124,000	124,000
Operating empty weight (kg)	79,450	72,400	82,600	73,900
Max zero fuel weight (kg)	113,000	113,000	114,000	114,000
Max payload (kg)	33,550	40,000	33,460	40,000
Powerplant	2 x 53,200lb	2 x 53,200lb	2 x 59,000lb	2 x 59,000lb
	GE CF6-80C2A2	GE CF6-80C2A2	GE CF6-80C2A8	GE CF6-80C2A8
	or 2 x 50,000lb	or 2 x 50,000lb	or 2 x 56,000lb	or 2 x 56,000lb
	P&W JT9D-7R4	P&W JT9D-7R4	P&W PW4156A	P&W PW4156A
Standard fuel capacity (l)	54,920	54,920	75,470	75,470
Normal operating speed (kt)	325	325	325	325
Normal operating speed (Mach)	0.79	0.79	0.79	0.79
Max cruise speed (kt)	484	484	484	484
Max cruising altitude (ft)	39,000	39,000	39,000	39,000
Take-off field length (m, sea level/ISA)	1,860	-	2,290	-
Landing field length (m, sea level/ISA)	1,480	-	1,490	-
Accommodation (1-class)	279	-	279	-
Accommodation (2-class)	218	-	218	-
Accommodation (3-class)	187	-	187	-
Design range with pax/payload	4,633km/220	5,550km/331*	9,600km/218	7,330km/331*

Notes * 80% volumetric payload

GE- and P&W-powered A300s were constructed.

The A300-600 was launched in 1980 featuring a two-crew EFIS flightdeck and entered service in March 1984. From the mid-1980s, the new version superseded the original A300B models, of which 250 were built. The last passenger derivative to be developed, the -600R, entered service in 1988. It has increased fuel capacity, heavier weights and extended-range capability.

Apart from the JAS aircraft, A300 production is now exclusively the -600 freighter version, which was launched by FedEx Express in 1991 and entered service in April 1994. This cargo model has since been purchased in large numbers by UPS Airlines. Last year UPS placed a follow-on order for 60 freighters which will keep the A300-600 production line active until at least May 2009. If options are exercised this will extend to 2012.

BAE Systems Aviation Services and EADS Dresden, Germany-based Elbe Flugzeugwerke (EFW) both developed freighter conversion programmes for the A300B4, and EFW has also received certification for a -600 conversion. FedEx became the first customer for EFW's A300-600 freighter conversion programme last year. The first aircraft was delivered in March 2002.

The industry downturn has forced BAE to close its conversion programme as it had no sustainable final orderbook. BAE has been seeking to sell the concern in its entirety or in parts. The company has completed design work on a conversion for the A300-600. This could be launched if a buyer is found for the business.

The crash of an American Airlines Airbus A300-600R shortly after take-off from New York Kennedy in November last year threw the spotlight on the

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A300/A310's carbonfibre tailfin, which separated in flight. The separation followed the A300 encountering wake vortices from a Japan Air Lines Boeing 747-400 which took off before it at Kennedy. Following the accident, the US FAA ordered that the fin mountings on all US-registered A300-600/600Rs be checked. The investigation has so far failed to find a design or structural fault, and is focusing on crew actions.

Production

Final assembly of the A300-600 is integrated with that of the A310 at Airbus France in Toulouse. Eleven A300/A310s (all A300s) were delivered last year. Production continues at a similar annual rate. A310 production is on a build-to-order basis.

Ordered: 583

Delivered: 516

A310

Lufthansa and Swissair put the 210-seat A310 into service in April 1983 in its basic -200 form. This short-fuselage derivative of the A300B4 featured a two-crew flightdeck and smaller, more advanced wing. The longer-range -300, which has increased weights and fuel capacity, was introduced in 1985.

Production of the A310 is now effectively suspended, as Airbus eyes a new family of aircraft to fill the A310's niche. The remaining order is the suspended Iraqi Airways contract for five aircraft. EADS EFWR offers a cargo conversion for the A310 (similar to its A300B4 modification) and has converted over



Iberia is a major A320 family operator, with over 60 A319s, A320s (pictured) and A321s in service

40 A310s to date, primarily for FedEx.

Germany was launch customer for the military multi-role tanker transport (MRTT) conversion for the A310, which is offered by an EADS Airbus (Germany)/Lufthansa Technik (LHT) consortium.

The four aircraft destined for Germany will be converted to the full MRTT specification in Hamburg between 2002 and 2004 through the installation of lower-deck fuel tanks and wing-mounted refuelling pods. The work will also involve fitting an operator's station behind the cockpit. The first delivery of an MRTT to Germany is scheduled for late 2003. The Canadian Forces are to have two A310s modified to

MRTTs, with deliveries of the aircraft scheduled for the third and fourth quarters of 2004.

EADS is developing an in-flight refuelling boom, and plans to flight test it on an A310-300 or A330-200 demonstrator between July and December 2005.

Production

See A300

Ordered: 260

Delivered: 255

A300/A310 replacement studies

Airbus has explored various avenues in its search for a new generation 200- to 250-seater to replace its two oldest models, the A300 and A310. Under study have been updated A300-based designs, further stretches of the A320 family – the "A322" – and shrink derivatives of the A330 – the -500.

Airbus is focusing on a widebody solution and is studying a smaller A330 as a possible replacement for the A300-600. It emerged this year that Airbus is in the early stages of a study into a new intermediate family of airliners that could form a broad replacement for the A300/A310 and plug the gap between the fly-by-wire A320 and A330/A340 families.

The new aircraft has a tentative entry-into-service date of around 2010 and Airbus has identified two "distinct markets" for a new family after a year of airline consultations. The first requirement is for a short-range aircraft seating 200 passengers and above, and the second for a long-haul type seating a "minimum" of 250 passengers in a multi-class layout and capable of flying 13,000km (7,000nm).

A318/A319/A320/A321

The launch of the 150-seat A320 in March 1984 marked Airbus's entry into the single-aisle, sub-200-seat market. The A320 family now comprises four models offering two-class seating capacity for 107 to 185 passengers.

The A320 – the world's first subsonic airliner to have a fly-by-wire FCS and composite primary structures – made its first flight in February 1987 and entered service with Air France just over a year later.

A stretched derivative, the 185-seat A321-100, was launched in 1989 and entered service with Lufthansa in March 1994. An extended-range version, the A321-200 with increased weights and fuel capacity, was introduced in 1997.

The first of two shorter-fuselage members, the

AIRBUS A320 FAMILY

	A318-100	A319-100	A320-200	A321-100/200
Length (m)	31.44	33.84	37.57	44.51
Wingspan (m)	34.1	34.1	34.1	34.1
Height (m)	12.56	11.76	11.76	11.76
Wing area (m ²)	122.6	122.4	122.4	122.4
Cabin width (m)	3.7	3.7	3.7	3.7
Max take-off weight (kg)	59,000	64,000	73,500	83,000
Option	63,000	68,000	75,500	85,000
Option	66,000	70,000	77,000	89,000
Option	68,000	75,500	-	93,000
Max landing weight (kg)	56,000	61,000	64,500	73,500
Option	57,500	62,500	66,000	77,800
Operating empty weight (kg)	39,470	40,300	42,100	48,080
Max zero fuel weight (kg)	53,000	58,500	62,500	71,500
Max payload (kg)	13,340	17,900	18,600	23,420
Powerplant	2 x 21,600-23,300lb CFM56-5B/P	2 x 22-23,500lb CFM56-5A or -5B	2 x 25-26,500lb CFM56-5A or -5B	2 x 30-33,00lb CFM56-5A or -5B
	or 2 x 22,100-23,800lb P&W PW6000	or 2 x 22-23,500lb IAE V2500-A5	or 2 x 25-26,500lb IAE V2500-A5	or 2 x 30-33,00lb IAE V2500-A5
Standard fuel capacity (l)	23,860	23,860	23,860	23,700
Option	-	26,850	26,850	26,690
Option	-	29,840	29,840	29,680
Normal operating speed (Mach)	0.78	0.78	0.78	0.78
Max cruise speed (Mach)	M.82	M.82	M.82	M.82
Max cruising altitude (ft)	39,000	39,000	39,000	39,000
Take-off field length (m)*	1,355**	1,950	2,090	2,180
Landing field length (m)*	1,356**	1,450	1,530	1,577
Accommodation (1-class)	117	150	180	220
Accommodation (2-class)	107	124	150	185
Design range	2,775km	4,700km	5,350km	5,000km
Option	6,010km***	6,800km	5,500km	5,500km
with pax	107	124	150	185

Notes *sea level/ISA. **P&W engines. ***68,000lb MTOW.

124-seat A319, was launched in June 1993 and entered service in May 1996 with Swissair. Deliveries began in 1999 with the Airbus Corporate Jet (ACJ) version of the A319 which, with up to seven auxiliary fuel tanks, can carry 10 passengers over distances up to 11,600km.

The 107-seat A318 is the latest derivative, which was launched in April 1999. Airbus had previously studied the development of an all-new 80- to 100-seat family (AE31X) with China and Singapore. The A318 is 4.5 frames shorter than the A319 from which it is derived, and is offered with the P&W PW6000 and CFM1 CFM56-5B. To compensate for the shorter moment arm, the surface area of the vertical stabiliser has been increased by extending the fin tip by around 0.8m.

The first A318 to fly was the PW6000-powered version, which took to the air on 14 January. By this time, major development problems had emerged with the PW6000 and P&W had decided to delay the programme by 30 months to allow the engine to undergo a major redesign. As a result, deliveries of PW6000-powered A318s slipped from the planned early 2003 target to mid-2005 and the CFM56 became the lead engine on the programme.

The prototype was grounded in June and re-engined with the CFM56-5, making its first flight in modified form 29 August. The first production CFM56-powered version is due to fly in May next year, when certification is due to allow deliveries to begin the following month to Frontier. The in-service date for the CFM56-powered version was brought forward by three months to compensate for the delay of the PW6000-powered version.

The prototype A318 will be returned to P&W power with the revised production standard PW6000 by October 2004. As a result of the delay, PW6000 customers Frontier Airlines and International Lease Finance switched to the CFM56 – the latter becoming launch customer. Air China, meanwhile, decided to drop its firm commitment for eight Airbus A318s and switch its order to the larger A319s. BA has also halved its orders for the PW6000-powered version to six aircraft.

Airbus has developed an increased capacity version of the A319, featuring two additional overwing emergency exits. Developed with low-fare airlines in mind, the extra doors increase the exit limit to enable the aircraft to carry around 150 passengers – similar to the rival Boeing 737-700.

Meanwhile, key low-fare A320 customers EasyJet and JetBlue are pushing Airbus to stretch the A320 by two seat rows to increase the capacity to around 190 passengers – similar to the rival 737-800. Airbus says it has no immediate plans for such a variant.

EADS EFW has developed a cargo conversion programme for the A320 family, which it expects to launch by 2004. The aircraft will feature a 3 x 2.15m forward cargo door, with the A320 freighter able to hold 11 standard pallets and carry a 20t payload, while the larger A321 will accommodate 14 pallets. EFW forecasts strong demand for freighter conversions of A321s, which could start in 2008.

The A320 family has been adopted as a platform for several military programmes. EADS/Alenia has

offered an A320-based design for the joint German/Italian competition to supply up to 24 maritime patrol aircraft. The A320 family is also being considered as a platform for NATO's air to ground surveillance aircraft requirement.

Northrop Grumman has held preliminary discussions with Airbus about using the Airbus A319 as a platform for future airborne early warning (AEW) aircraft, following the demise of the Fairchild Dornier 728 that it had previously planned to use.

Honeywell is to study more-electric and all-electric concepts for future aircraft and engines and suggests that a potential application "within a decade" could be a second-generation A320 family. Airbus has long been studying potential new A320 developments, but says it will not make a decision on the future of the family until Boeing decides on a replacement for the Next Generation 737. The company believes that the A320 could remain competitive with a fly-by-wire version of the Boeing 737 with "minor clean-up and upgraded engines".

Production

Final assembly of Airbus narrowbodies is undertaken at two sites – Airbus France builds the A320 at Toulouse, while Airbus Deutschland has responsibility for the A318, A319 and A321 at its Hamburg plant. In 2001, 257 A320 family aircraft – 119 A320s and 138 A319/A321s – were delivered.

Until mid-2001, the single-aisle production rate had been steadily increasing to a target of 30 a month by the end of this year. Output is now running at around 22 a month.

In the long term, Airbus Deutschland is expected to take over final assembly of the A320 from its

French partner. Although officially denied by Airbus, it is understood that the deal was struck as part of the agreement to allow final assembly of the 550-seat A380 to be undertaken in Toulouse rather than in Hamburg.

Ordered: 2,862 (103 A318s, 734 A319s, 1,609 A320s, 416 A321s)
Delivered: 1,819 (472 A319s, 1,098 A320s, 249 A321s)

A330

The A330 twinjet was launched with the four-engined A340 in June 1987 as a single, two-aircraft programme, marking the company's entry into the medium-long-haul market.

Two sizes of A330 are offered: the baseline 335-seat (two-class) A330-300, which was the first variant; and the shorter fuselage, 253-seat (three-class) -200. All A330 versions are offered with all of the major engine manufacturers' powerplants, including the GE CF6-80E1, P&W PW4168/4168 and R-R Trent 772.

The A330-300 entered service in January 1994, with the -200 following in April 1998. Designed to operate 12,000km missions, the -200 is 10 frames (5.33m) shorter than the -300 and has increased weights and extra fuel capacity.

Two additional A330 variants have been planned, but are now on hold: the shorter, 222-seat (three-class) A330-500 that was proposed in 2000 as a replacement for the A300/A310 family; and a freighter version of the -200. Both programmes were suspended when Airbus failed to attract any launch customers

AIRBUS A330

	-200	300
Length (m)	59	63.6
Wingspan (m)	60.3	60.3
Height (m)	17.9	16.7
Wing area (m ²)	361.6	361.6
Cabin width (m)	5.28	5.28
Max take-off weight (kg)	230,000	230,000
MTOW option	233,000	233,000
Max landing weight (kg)	182,000	187,000
Operating empty weight (kg)	120,533	123,140
Max zero fuel weight (kg)	170,000	175,000
Max payload (kg)	49,467	51,680
Powerplant	2 x 72,000lb GE CF6-80E1A3 or 2 x 68,000lb P&W PW4168A	2 x 72,000lb GE GE CF6-80E1A3 or 2 x 68,000lb P&W P&W PW4168A
	or 2 x 71,100lb R-R Trent 772	or 2 x 71,100lb R-R Trent 772
Standard fuel capacity (l)	139,090	97,530
Normal operating speed (Mach)	0.82	0.82
Max cruise speed (kt)	492	493
Max cruising altitude (ft)	41,100	41,100
Take-off field length (m, sea level/ISA)	2,220	2,500
Landing field length (m, sea level/ISA)	1,750	1,750
Accommodation (1-class)	406	440
Accommodation (2-class)	293	335
Accommodation (3-class)	253	295
Design range with pax	12,000km/253	10,400km/295
Option with pax	12,300km/253	10,500km/295

Notes *estimate



Airbus continues to develop the CFM56-powered A340-300, with enhanced models arriving in 2004

Airbus continues to seek an A330-200F launch customer, with LanChile emerging earlier this year as one potential customer. Studies also continue into a further A330 shrink to replace the A300/A310 (see A300/A310 replacement studies above).

A long-range variant of the A330-300 is also being studied to provide a direct rival to lower weight Boeing 777 models. Dubbed the A330-300 "high-gross-weight" (HGW), the model would have a 7t increase in MTOW to 240t, associated structural strengthening of the wing, increased fuel capacity (to 139,000 litres) and more powerful engines. These changes would boost the range of the 295-seater to around 11,100km.

The A330 is the lead aircraft in the A330/A340 Enhanced programme, which is effectively a mid-life update for the two long-range widebodies. The key elements of the enhancements come from new developments for the A340-500/600 and include the fly-by-wire controlled rudder, improved flightdeck features (including liquid crystal displays, updated cabin and a new rear crew-rest area option). The new features are expected to become standard across the range in the longer term.

The lead Enhanced aircraft is an A330-300 for Northwest Airlines due for delivery in mid-2003. The second variant will be an A330-200 for EVA Airways due in early 2004.

Qantas is soon to become one of the first airlines to fly a "paperless" cockpit avionics suite in revenue service when it takes delivery of its Airbus A330s. The system provides pilots with an "electronic flight-bag", comprising digitally stored maps, approach plates, performance flight manuals and charts. The cockpit is equipped with an additional pair of screens – one on each side – to enable the pilots to monitor aircraft position superimposed on a "moving map" showing topographical, aeronautical and procedural data.

The aim is to eliminate the need for crew to carry folders of charts and books of aeronautical informa-

tion and flight documentation, reducing costs.

A tanker version of the A330, dubbed the KC-330, was proposed by EADS earlier this year to meet the US Air Force's requirement for 100 leased tankers. The Airbus-based offering was rejected in favour of Boeing 767 tankers. The European company is promoting the A330 as an alternative platform to the 767 for the USAF's Multirole Command and Control Aircraft (MC2A).

The A330 tanker is being offered by the AirTanker consortium to meet the UK Ministry of Defence's requirement for Future Strategic Tanker Aircraft (FSTA). The A330 is competing against a Boeing 767-based offering. The manufacturers are bidding

to provide around 20 tankers for 27 years, which the MoD will fund using a private finance initiative (PFI). Earlier this year, the MoD delayed the target entry into service date for the aircraft by 12 months, with introduction now due to start in early 2008. A selection is expected by the end of this year.

Production

Airbus France performs final assembly of the A330 alongside the A340 at Toulouse. Last year, Airbus delivered 35 A330s and 22 A340s. Output had been due to increase to eight per month during 2002, but is currently running at around four.

Ordered: 410

Delivered: 235

A340

Launched in parallel with the A330 in June 1987, the four-engined A340 can be categorised into two distinct families – the CFM56-5C- powered 260- to 295-seat -200/300 and the R-R Trent 500-powered 310- to 380-seat -500/600.

The -300 was the first to fly, in October 1991, and this version entered commercial service in March 1993 with Air France. Lufthansa put the smaller -200 into service the same month. A higher gross-weight -300 version developed for Singapore Airlines entered service in April 1996. A very-long-range derivative of the smaller -200, dubbed the A340-800 (the name is derived from its 8,000nm range) was also developed, although only one has been built for a VIP operator.

Airbus launched the A340-500/600 models in December 1997, with the new family featuring a 20% larger wing with 1.6m wing-tip extensions. Because of the increased take-off weights, a four-wheel centre main undercarriage assembly replaces the existing two-wheel unit.

A340-600 flight testing began in April last year. The 1,600h certification programme involved three

AIRBUS A340	-200	-300	-500	-600
Length (m)	59.4	63.7	67.9	75.3
Wingspan (m)	60.3	60.3	63.45	63.45
Height (m)	16.83	16.83	17.1	17.29
Wing area (m ²)	361.63	361.63	437.3	437.3
Cabin width (m)	5.28	5.28	5.28	5.28
Max take-off weight (kg)	275,000	271,000	365,000	365,000
MTOW option	-	275,000	368,000	368,000
Max landing weight (kg)	185,000	192,000	236,000	254,000
Operating empty weight (kg)	129,000	130,080	170,400	177,000
Max zero fuel weight (kg)	173,000	181,000	222,000	240,000
Max payload (kg)	43,500	50,920	51,200	62,300
Powerplant	4 x 34,000lb CFMI CFM56-5C4	4 x 34,000lb CFMI CFM56-5C4	4 x 53,000lb R-R Trent 553	4 x 56,000lb R-R Trent 556
Standard fuel capacity (l)	155,040	141,500	214,800	194,880
Normal operating speed (Mach)	0.82	0.82	0.83	0.83
Max cruise speed (kt)	493	493	492	492
Max cruising altitude (ft)	41,100	41,100	41,100	41,100
Take-off field length (m, sea level/ISA)	2,990	3,000	3,050	3,100
Landing field length (m, sea level/ISA)	1,890	1,926	2,010	2,100
Accommodation (1-class)	420	440	440	440
Accommodation (2-class)	300	335	-	-
Accommodation (3-class)	239-263	295	313	380
Design range with pax	14,800km/239	13,100km/295	15,750km/313	13,900km/380
Option	-	13,500km/295	16,000km/313	-

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aircraft making 500 flights. JAA certification was awarded in May and FAA approval followed in July. Virgin Atlantic put the -600 into service at the beginning of August. Deliveries to the next customer, Cathay Pacific, have been delayed by two months as a result of production hold-ups and apparent specification changes requested by the airline.

During testing it was established that the A340-600's climb to initial cruise altitude performance at maximum take-off weight is "significantly better" than the target of FL 330 (33,000ft/10,000m).

Airbus had to rerun its rejected take-off certification tests for the -600, after many of the wheels suffered structural failure during the original test when tyre pressure rose dramatically because of brake heat. The wheels and tyres were redesigned and a second test was completed successfully.

Early build A340-500/600s have weighed in heavier than the target, with the deficit believed to be around 850kg. This is largely thought to be associated with the aircraft's wing. A weight-saving programme is expected to bring the new A340 models within 0.4% of the originally specified empty weight by aircraft number 23, which is the first A340-500 for Singapore Airlines.

Airbus UK's Filton plant is masterminding the weight-saving effort, which is understood to focus on reducing material used in various stringers and ribs in the wing as well as removing material from some of the larger forgings within the structure.

R-R is also developing an enhanced performance package for the Trent 500 which will include scheduling changes to the full authority digital engine control, reduced clearances in the intermediate-pressure compressor and alterations to increase the turbine exit temperature.

The smaller, ultra-long-range A340-500 flew on 11 February this year and is completing its short flight-test programme. Airbus has delayed deliveries of the A340-500 to launch customer Air Canada by around four months, until March next year, as a result of post-certification changes.

A corporate A340-500 is being built for Qatar Airways, with delivery set for 2004.

Meanwhile, Airbus is studying the development of a higher weight, extended-range version of the -600 for Emirates. The UAE airline wants to supplement its A340-500 fleet with a -600 capable of flying year-round from Dubai to the USA. The airline holds a letter of intent for eight aircraft, pending a decision by Airbus to go ahead with the new version.

Flight testing of the improved CFM56-5C/P engine for the A340-300 Enhanced model is about to begin on the company-owned prototype. The aircraft will complete 50h of performance and operability flight tests. Engine certification is due in the third quarter of next year. A short flight-test programme will be flown on the first customer aircraft ahead of its delivery to South African Airways in February 2004. SAA ordered six of the A340-300 Enhanced earlier this year.

Other enhancements, which will also apply to the A330, come from new developments for the A340-500/600, including the fly-by-wire controlled rudder, improved flightdeck (including liquid crystal displays, updated cabin and a new rear crew-rest area option.

AIRBUS A380		
	A380-800	A380-800 Freighter
Length (m)	72.7	72.7
Wingspan (m)	79.6	79.6
Height (m)	24.07	24.07
Cabin width (m)	6.55	6.55
Max take-off weight (kg)	560,000	590,000
MTOW option	-	600,000
Max landing weight (kg)	386,000	427,000
Operating empty weight (kg)	277,000	252,200
Max zero fuel weight (kg)	361,000	402,000
Max payload (kg)	83,000	150,000
Option	-	158,000
Powerplant	4 x 70,000lb GE-PW Engine Alliance GP7200 or R-R Trent 900	4 x 76,500lb GE-PW Engine Alliance GP7200 or R-R Trent 900
Standard fuel capacity (l)	310,000	310,000
Option	-	352,000
Normal operating speed (Mach)	0.85	0.85
Max cruise speed (Mach)	0.89	0.89
Max cruise speed (kt)	340	340
Max cruising altitude (ft)	43,000	43,000
Take-off field length (m, sea level/ISA)	2,050	2,900
Landing field length (m, sea level/ISA)	2,900	1,900
Accommodation (1-class)	822	71 containers
Accommodation (3-class)	555	-
Design range with pax/load	14,200km/555	10,400km/150t payload
Design range with maximum load	-	5,550km/185t payload

Airbus promises that the CFM56-5C/P engine will provide 10% lower maintenance costs and a 1% improvement in specific fuel consumption compared with the A340-300's present CFM56-5C4. The enhanced engine improvement package will also be available as an upgrade kit.

The A340-300 testbed's next chore will be to test Messier-Dowty's noise-reducing components for A340 landing gear, beginning next September. The work is part of the European SILENCER noise-reduction programme. Add-on fairings have been designed for the nose, centre and main landing gear of the A340-300.

Production

See A330.

Ordered: 325

Delivered: 218

A380

The \$10.7 billion A380 programme was formally launched in December 2000, but the aircraft had been under development since April 1996 under the "A3XX" designation. Launched with the backing of commitments from six customers for 48 orders, the total order book now stands at 95 aircraft from eight customers.

The baseline 555-seat passenger version is designated the A380-800, and an -800 Freighter is also being developed. Future planned models include a longer-range version, the -800R, as well as a 650-seat stretch, the -900, and a 465-seat shrink, the -700.

The four-engined A380 is available with a choice of powerplants in the 70,000-78,000lb-thrust bracket, with R-R offering the Trent 900 and the GE-P&W Engine Alliance the GP7200.

The Trent 900 is the lead certification engine and

has been selected by Lufthansa, Qantas, SIA and Virgin. Air France, Emirates and FedEx have chosen the GP7200. The Trent-powered A380 is to make its maiden flight in late 2004, and enter service with SIA in March 2006. Emirates will receive the first GP7200-powered A380 in July 2006. According to EADS, there is a market for 750 A380s through to 2015. Break-even will be around 250 aircraft. EADS is confident that the programme will be in the black by 2011.

The freighter is due to enter service in June 2008 with Emirates. FedEx will also receive its first aircraft that year. The A380-800F will have strengthened structure and increased weights, giving it a standard payload of 150t. Airbus is offering various weight options which provide increased range and/or payload. These include a 10t MTOW increase and 8t more payload. A centre fuel tank is also being offered. The freighter's strengthened airframe will provide the basis for the stretched A380-900 model.

The freighter will have a 4.27 x 2.87m cargo door on its main deck and a 3.68 x 2.24m door on the upper deck. Total cargo volume will be 948m³.

Airbus published the first of its series of A380 technical manuals this year. It covers aeroplane characteristics for airport planning for the passenger and cargo models, enabling airports to plan manoeuvring areas, pavement strength, runway dimensions and loading gate design. Airbus estimates the freighter should be able to be turned around in 100-140min, and the passenger version in 80-123min.

A380 manufacturing began in early 2002, with the first carbonfibre panels being made at the Airbus France plant in Nantes and the first metal cut at the French plant in Méaulle and the

German aluminium milling factory in Varel. Fuselage panel manufacturing also began in Nordenham, Germany, while Airbus UK has started cutting metal for the first A380 wings at Filton.

Construction of major component assembly hall and other A380-related structures is under way at Hamburg, as is the wing assembly plant at Airbus UK's Broughton site. Work is also under way on the A380 assembly plant in Toulouse, dubbed Aeroconstellation, which is due to be completed by the end of next year.

Production

A380 final assembly will be undertaken by Airbus France at its new Aeroconstellation complex in Toulouse. Airbus Deutschland in Hamburg will have responsibility for interior installation as well as delivery of aircraft to customers in Europe and the Middle East.

The division of work on the A380 is similar to earlier programmes, with Airbus France responsible for the cockpit and centre fuselage section, Airbus Deutschland for the forward and rear fuselages and vertical stabiliser, Airbus España for the horizontal tailplane, and Airbus UK for the wing.

Because of their size, Airbus will deliver A380 sections to Toulouse by a novel combination of sea, river and road, rather than by air, as the subassemblies for current models are transported. A380 production will eventually settle at one aircraft a week.

Government refundable loans account for 33% of the programme's cost, with the rest being funded by the Airbus partners EADS and BAE Systems. About \$2.1 billion of the costs are being covered by risk-sharing partners on the airframe, and \$900 million by equipment vendors.

Airbus is finalising equipment vendor selection for the A380 and has takers for most of the risk-sharing work. Contracts cover flight control, fuel, electrical, hydraulic and environmental systems, cockpit avionics, landing gear, engines, nacelles and evacuation slides. Over 30 risk-sharing partners have been secured, with Airbus planning to outsource around 30% of the programme's cost. Partners include Alenia, CTM of Malaysia, EADS Socata, EADS Sogerma, Eurocopter, Finavitte, Fokker, Gamesa, GKN, Labinal, Saab, Sabca and Sonaca. Korea Aerospace Industries is expected to sign up for a 1.5% stake and produce aluminium wing panels.

Orders: 95

Deliveries: 0

ANTONOV

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An-70T

This four-engined propfan-powered airlifter is designed as a military transport, but a commercial version has been proposed. The An-70T first flew in December 1994, but the programme was thrown into turmoil after the fatal crash of the single prototype in February 1995, following a mid-air collision with an An-72 chase aircraft.

Antonov converted the second, static-test prototype to flight status and it was flown in April 1997. An expected firm order from the Russian air force has still not been confirmed.

There have been discussions between Russian cargo airline Volga-Dnepr and the design bureau's Antonov Airlines to introduce the An-70 as a commercial freighter.

Antonov has investigated the development of a twin-engined variant, the An-70T-100, powered by the same Progress D-27 propfans, which would not have the standard An-70's short take-off capability but would be lighter and less expensive.

The An-70 prototype completed its certification tests in August, but approval also requires a production aircraft to be completed and audited. The first production airframe is close to completion at the Aviant factory in Kiev, but is not expected to fly until mid-2003.

Production

Polet will undertake series production of the An-70 at its plant in Omsk. The factory, which is better known for its space launcher work, repaired the An-70 prototype that was damaged in an accident at Omsk in January 2001. The setting up of a production line will cost roughly \$100 million, part of which will come from federal and regional budgets.

Aviakor, in Samara, Russia, was originally designated to build the An-70, but it was unable to raise enough financing. Aviakor could still receive a share of the programme, probably production of the wing.

An-124 Ruslan

The An-124 made its first flight in December 1982 and entered service in January 1986. Although conceived originally for use by the Russian military, the 150t-payload An-124 has found a market niche with Western cargo operators because it can carry very heavy, oversized loads.

The civil version is designated the An-124-100, and Russian outside cargo carrier Volga-Dnepr is undertaking a \$2 million project to gain European JAA certification for the aircraft through the UK CAA. Meetings have already been held with CAA officials. The Antonov design bureau and Russian airworthi-

ness body MAK are involved in the programme, which is expected to be completed next year.

Volga-Dnepr says that European JAA approval would enable the aircraft to be registered in the UK and acquired by Western airlines. The airline could also use the aircraft as collateral to generate finance from Western banks.

In July, Volga-Dnepr secured a \$30 million loan from the World Bank to fund the completion of an An-124-100 at Aviastar in Ulyanovsk, Russia. The aircraft will be the airline's tenth purchase.

Additional civil An-124s are being created by the modification and upgrading of ex-Russian air force aircraft. Polet Airline of Voronezh took delivery of the first of five ex-military An-124s earlier this year following major overhaul and conversion to the civil An-124-100 standard by Aviastar. Polet has invested over \$20 million to have Aviastar upgrade the ex-Russian air force aircraft, including the purchase of four new ZMKB D-18T Series 3 engines.

Two of Polet's An-124s will be -100VS models equipped to deploy from the rear loading ramp the 100t launch vehicle being developed by the Air Launch Aerospace joint venture. Polet has placed an order with Aviastar for a new Ruslan for delivery in 2003.

Volga-Dnepr has proposed converting an An-124 to air-launch space boosters from the upper fuselage. Last year it linked with the Khronichev space centre as part of an alliance to reduce the costs of launch services by using the An-124 to transport space hardware between the manufacturing site and launch pad.

The An-124's original design life was set at 6,000 flight hours. Volga-Dnepr and its rival Antonov Airlines (a subsidiary of the design bureau) have agreed a joint approach to extending the lives of airframes and engines. New production aircraft have their airframe lives extended to 24,000h.

A Chapter 3 hushkit developed by the engine design bureau ZMKB Progress in conjunction with Antonov was certificated in mid-1997 for the An-124's D-18T turbofans.

Antonov is working with ZMKB Progress and the Motor-Sich production plant to make the An-124-

ANTONOV			
	An-70T	An-124-100	An-225
Length (m)	40.73	69.1	84
Wingspan (m)	44.06	73.3	88.4
Height (m)	16.38	21.08	18.2
Wing area (m ²)	204	628	905
Cabin width (m)	204	6.4	6.4
Max take-off weight (kg)	131,500	392,000	600,000
Max landing weight (kg)		330,000	-
Operating empty weight (kg)	72,800	178,000	-
Max zero fuel weight (kg)	114,000	325,000	-
Max payload (kg)	47,000	120,000	250,000
Powerplant	4 x 10,430lb Ivchenko Progress ZMKB D-27F Propfan	4 x 51,630lb Ivchenko Progress ZMKB D-18T	6 x 51,630lb Ivchenko Progress ZMKB D-18T
Standard fuel capacity (l)	-	348,740	-
Max cruise speed (kt)	431.2	467	460
Max cruising altitude (ft)	31,500	-	-
Take-off field length (m) (sea level/ISA)	1,800	2,800	3,500
Landing field length (m) (sea level/ISA)	1,800	2,400	-
Design range with payload	3,800km/35t	8,400km/80t	4,500km/200t

Directory: world airliners

100 and larger, six-engined An-225 compliant with ICAO Chapter 4 noise requirements. A study has revealed the fan of the D-18T engine will need to be redesigned, with upgrades to the nacelle also required, including installation of additional noise-attenuation material.

Production

Aviastar builds the An-124 at its plant in Ulyanovsk. A new batch of three An-124-100s has been produced by Aviastar for Russian airline Volga-Dnepr. The final aircraft built at the Gostomel plant near Kiev in Ukraine has been completed, but is awaiting a customer.

Delivered: c50

An-225 Mriya

The only example of the six-engined, 250t payload Antonov An-225 Mriya heavy-lifter returned to commercial operations in January with Antonov Airlines, following its resurrection after years in storage. The first commercial flight was from Stuttgart in Germany to Thumrait in southern Oman on 3 January, carrying 188t of food for US military personnel.

An-124 leasing specialist Air Foyle has master-minded the project with the Antonov design bureau. The An-225 made its first flight in May last year after seven years in storage. Making the aircraft airworthy was a six-month effort that cost \$20 million, with funds being provided by Antonov and engine-maker Motor-Sich. The upgraded aircraft has new avionics and improved D-18T engines to enable it to meet Chapter 3 noise regulations.

Air Foyle now operates the AFH joint venture with HeavyLift to market the aircraft internationally. Shortly after completing several commercial flights, the aircraft was grounded temporarily for modifications, but returned to operation from May. AFH

expects the An-225 to fly around 500-700h during the first 12 months of operations.

A stretched development of the An-124, Mriya made its maiden flight in December 1988 and was built to carry Russia's Buran shuttle spacecraft before the project was cancelled. Work on a second air-frame halted in 1994, but Antonov says it could be resurrected if justified by the market.

Antonov, ZMKB Progress and Motor-Sich are to develop modifications to enable the An-225 to be compliant with ICAO Chapter 4 noise limits. (see An-124 above).

Delivered: 1

BOEING

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Boeing and McDonnell Douglas (MDC) merged in August 1997. All the in-production MDC types were redesignated as Boeings and are included in the Boeing section of this directory. The 100-seater 717 (previously the MD-95) is included in next week's Part 2. All "MD" aircraft are now out of production, with the last examples – two MD-11Fs for Lufthansa Cargo – delivered in 2001.

707/720

Boeing's jet-powered airliner project, the 367-80, was launched as a privately funded venture in 1952. The "Dash 80", which was effectively the 707 prototype, was flown in July 1954 and aimed at the expected huge market for such an aircraft in civil and military applications. The 707-100 entered service with Pan American Airways in October 1958. Boeing also developed a military tanker/transport version, the model 717, designated the KC-135.

The -100 was superseded by the higher-powered -200. A larger, longer-range 707 derivative, the -320B/C, fitted with P&W JT3D turbofans, became the standard production version from the early 1960s. An R-R Conway-powered model, the 707-400, was also produced in limited numbers. A total of 154 of the smaller, short-range model, the 720, was also produced between 1959 and 1967. The last civil 707 was delivered in 1979.

About 80 commercially operated 707s remain in an operational status, about half of which are believed to be flying. Almost all the aircraft are 707-300 series freighters. Chapter 3 hushkits have been developed by Burbank Aeronautical II (BAC II) and Quiet Technology Venture (QTV, formerly Quiet Nacelle) of the USA. The former closed earlier this year after failing to re-emerge from Chapter 11 bankruptcy protection.

San Antonio, Texas-based Seven Q Seven has developed a P&W JT8D-219 re-engining programme which was selected in August for the US Air Force's 707-320-based E-8C Joint Surveillance Target Attack Radar System (JSTARS) fleet. Funding has yet to be secured for the programme, to be implemented through an operating lease, but is targeted for 2003 or 2004.

The team, which is led by Irish 707 leasing specialist Omega Air, includes P&W (engines and exhaust transition ducts), Goodrich (inlets and reversers) and Nordam (struts and cowl doors).

Flight-testing of a 707-320 re-engined with JT8D-219s began in August last year, and an FAA STC is expected to be issued in December at an initial thrust rating of 19,000lb. Approval at 21,000lb thrust is planned for March.

In addition to the 18 planned E-8s, Seven Q Seven hopes to re-engine NATO's Boeing E-3 Airborne Warning and Control System aircraft, and possibly the USAF's E-3 fleet. The package, which provides Chapter 3 noise compliance and improved performance, is also offered to the commercial market.

The Bedek division of Israel Aircraft Industries is offering a major life extension and upgrade package for the 707, based on an aircraft developed for the Israeli air force, which could include a glass cockpit and re-engining. Earlier this year Bedek was contracted to convert 707-320s to tankers for the Israeli air force, with modifications to include the installation of new avionics, a new mission computer with colour displays and advanced communication systems. The upgrade programme is partly based on the corrosion prevention control programme (CPCP) that was developed for the Israeli air force 707s.

Delivered: 1,009 (with military versions and 720)
In service: 299 (including military versions)

717 – see Part 2

727

The 727 tri-jet made its first flight in February 1963, in initial -100 form. This version entered service in February 1964 and a stretched -200 followed in December 1967. Boeing delivered the last 727, a -200F for FedEx Express, in September 1984.

The active fleet of 727s has declined rapidly in

BOEING 707/727/737-200

	707-320C	727-100QF	727-200 Adv	737-200 Adv
Length (m)	46.61	40.59	46.69	30.53
Wingspan (m)	44.42	32.92	32.92	28.35
Height (m)	12.93	10.36	10.4	11.23
Wing area (m ²)	283	158	157.9	91.1
Cabin width (m)	3.55	3.55	3.28	3.53
Max take-off weight (kg)	151,315	72,640	83,900	52,390
MTOW option		72,640	95,100	58,150
Max landing weight (kg)	112,037	64,638	79,150	46,720
Operating empty weight (kg)	64,000	-	44,300	27,515
Max zero fuel weight (kg)	104,330	59,875	62,650	43,091
Max payload (kg)	40,330	20,865	18,340	15,710
Powerplant	4 x 18,960lb P&W JT3D-7	3 x 15,390lb R-R Tay 651	3 x 16,000lb P&W JT8D-17 or 3 x 17,400lb P&W JT8D-17R	2 x 15,480lb P&W JT8D-15A
Standard fuel capacity (l)	90,299	29,107	30,622	19,532
Normal operating speed (kt)			350	350
Normal operating speed (Mach)			0.88	0.745
Max cruise speed (kt)	525	470	530	500
Max cruising altitude (ft)	38,500	-	-	-
Take-off field length (m) (sea level/ISA)	-	-	3,033	1,990
Landing field length (m) (sea level/ISA)	-	-	1,494	1,350
Accommodation (1-class)	-	-	189	130
Accommodation (2-class)	-	-	145	102
Design range with pax/payload 5,550km/34t load	-	-	3,515km/134	2,960km/120
Option with pax	-	-	4,720km/134	3,700km/120

the wake of 11 September, with 731 believed to be operational from a potential 1,173 aircraft. The 727 has the largest single stored fleet of any Western-built jet type.

A number of methods have been developed to keep the aircraft compliant with the latest noise limits, but demand has been weakened by the decline in the active fleet. FedEx Aviation Services offers the only Chapter 3 hushkit for the 727 and has delivered more than 800 sets. Goodrich offers a P&W JT8D-200 re-engining programme for the 727, called the "Super 27" (previously marketed by Valsan).

Two US specialists, Raisbeck and DuganAir Technologies (Quiet Wing System), have each engineered Stage 3 solutions that rely heavily on reconfigured flap and slat settings, and reduced thrust. No Chapter 4 modifications are known to be in development for the tri-jet.

Quiet Wing, DuganAir's Washington-based parent company, linked with conversion firm Stambaugh Aviation last year to develop a freighter conversion programme for the 727.

Delivered: 1,831

In service: 1,173 (including 442 stored)

737-100/200

Nine distinct variants of the Boeing 737 have been developed since the original 85-seat -100 flew in April 1967. This model entered service with Lufthansa in December 1967, but was quickly superseded by the slightly larger -200, the first of which was delivered to United Airlines the same month.

Just 30 -100s were built before production of the JT8D-powered twinjet standardised on the 102-seat -200. This model remained in production until 1988, by which time it had been superseded by the original CFM56-powered 737 family.

In November 2001, the US FAA unveiled plans to make compulsory a complete rudder control system retrofit on all Boeing 737s. Last month, the US FAA issued its final AD requiring all 737s to be modified by November 2008, a year later than originally proposed. The move was prompted by a number of rudder incidents, including the fatal accidents in 1991 of the United Airlines 737-200 at Colorado Springs and in 1994 of a USAir 737-300 at Pittsburgh, both of which were judged to have been caused by large, uncommanded rudder deflections.

The AD affects 2,000 US-registered 737s and up to 2,500 aircraft outside the USA. Boeing will provide the hardware at no cost to the airlines, but the FAA estimates each installation will take 700h and cost \$182,000, for a total projected cost to US carriers of \$364 million. New hydraulic actuators, control rods and torque tubes will be installed during major maintenance checks.

Two US companies, Nordam and AvAero, have developed Stage 3 hushkits for the JT8D-powered 737. P&W has also proposed a PW6000 re-engining programme for the 737-200 and early CFM56-powered models.

Delivered: 1,144

In service: 878 (including 248 stored)

737-300/400/500 ('CFM Classic')

The 737-300, introduced in 1984, was the first of

three new CFM56-3 powered models to be developed. The family encompassed the larger -400 and smaller -500 model. Other improvements include a modified wing, and more advanced flightdeck and digital avionics.

With the introduction of the Next Generation 737 family in 1998, the earlier CFM56-powered models are now referred to as the "737 Classic". From the first flight of the 737-300 in February 1984 to the delivery of the last -400 in February 2000, production of the 737 Classic spanned 16 years and totalled around 1,988 aircraft.

The 128-seat 737-300 entered service with US Airways and Southwest Airlines in November 1984, and was followed by the stretched 146-seat -400 four years later. Piedmont Airlines (now US Airways) took delivery of the first -400 in September 1988. The 108-seat -500, which is similar in size to the -200, went into service with Southwest Airlines in February 1990.

Three cargo-conversion programmes are being developed for the 737 Classic. Pemco was awarded an STC in April for a strengthened version of its earlier 737 cargo conversion. It has also completed a service bulletin to allow operators of its earlier converted 737-300s to comply with revised certification requirements.

IAI's Bedek division has started work on the first of 15 737-300/400 conversions for GECAS, the first of which are due for delivery in mid-2003.

Boeing has had a two-year partnership with Goodrich Aviation Technical Services and Taiwanese consortium Inter-Continental Aircraft Services (ICAS) to develop a 737 Classic cargo conversion, but the programme has been stalled due to the lack of a launch customer. The partners have concluded a new agreement which will see more responsibility transferred to Goodrich and ICAS in a bid to reduce costs on the programme

and cut the sticker price for the conversion.

Under the agreement Goodrich and ICAS will share the design effort and conduct the conversions at their facilities in Seattle and Taiwan, respectively, while Boeing will provide data, analysis and technical expertise. Goodrich will lead the certification effort and obtain the STC using Boeing FAA-approved type design data.

The 737-300 freighter can carry eight cargo pallets and has an 18,800kg payload, while the larger -400's capacity is nine pallets and a 19,000-20,900kg payload, depending on weights.

APB is to begin flight tests of a winglet-equipped Boeing 737-300 this month, with an STC expected in January. The composite blended winglets are 2.1m tall, slightly shorter than units installed on the Next Generation 737, and weigh around 66kg apiece. They are expected to net a 5% reduction in block fuel consumption on a 2,780km flight, as well as enhancing field performance, providing higher operating weight capability and improving time-to-climb.

Kawasaki Heavy Industries (KHI) has been contracted to manufacture the winglets and says it expects to manufacture around 550 shipsets.

A winglet STC effort for the 737-400 is due to start early next year, with certification set for June and retrofits offered in the third quarter onwards.

Deliveries began in mid-2002 of a core upgrade kit for the 737 Classic's CFM56-3 to launch customer Southwest Airlines. Delivery of the time on wing (TOW) kit is due to run at up to eight a month, with 50 kits due for handover this year. CFMI, which says the upgrade saves up to 1% specific fuel consumption, estimates a market for around 1,000 CFM56-3 engines, or around 25% of the world fleet.

The kit, which is fitted into the engine core during major overhaul, increases exhaust gas temperature margins by an average of 15°C and results in up to 1,400 additional cycles.

BOEING 737 CFM CLASSIC

	-300	-400	-500
Length (m)	33.4	36.45	31.01
Wingspan (m)	28.88	28.88	28.88
Height (m)	11.12	11.12	11.12
Wing area (m ²)	105.4	105.4	105.4
Cabin width (m)	3.53	3.53	3.53
Max take-off weight (kg)	56,500	62,900	52,440
MTOW option	62,820	68,100	60,560
Max landing weight (kg)	51,710	54,900	49,890
Option	52,880	56,240	-
Operating empty weight (kg)	32,820	34,820	31,950
Max zero fuel weight (kg)	47,620	53,070	46,720
Max payload (kg)	14,805	18,260	14,770
Powerplant	2 x 22-23,500lb CFM1 CFM56-3B or -3C	2 x 22-23,500lb CFM56-3B2 or -3C1	2 x 18,500-20,000lb CFM56-3B1 or -3C1
Standard fuel capacity (l)	20,104	23,830	23,830
Normal operating speed (Mach)	0.745	0.745	0.745
Max cruise speed (kt)	491	492	492
Max cruising altitude (ft)	37,000	37,000	37,000
Take-off field length (m, sea level/ISA)	1,939	2,540	2,470
Landing field length (m, sea level/ISA)	1,396	1,540	1,360
Accommodation (1-class)	149	171	132
Accommodation (2-class)	128	146	108
Design range with pax	2,990km/141	4,000km/146	3,330km/108
Option with pax	4,790km/141	4,625km/146	5,550km/108

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BOEING 737 NEXT GENERATION FAMILY

	-600	-700	-800	-900
Length (m)	31.2	33.6	39.5	42.1
Wingspan (m)	34.31	34.31	34.31	34.31
Height (m)	12.5	12.5	12.5	12.5
Wing area (m ²)	125	125	125	125
Cabin width (m)	3.54	3.54	3.54	3.54
Max take-off weight (kg)	56,250	60,330	78,240	78,240
MTOW option	65,090	70,000	79,000	79,000
Max landing weight (kg)	54,660	58,060	65,320	66,360
Operating empty weight (kg)	37,100	38,145	41,145	42,490
Max zero fuel weight (kg)	51,480	54,660	61,690	62,730
Max payload (kg)	14,380	16,505	20,540	20,240
Powerplant	2 x 18,500-22,690lb	2 x 20,500-24,170lb	2 x 24,170-26,290lb	2 x 24,170-26,290lb
	CFMI CFM56	CFMI CFM56	CFMI CFM56	CFMI CFM56
	-7B18/20/22	-7B20/22/24	-7B24/26	-7B24/26/27
Standard fuel capacity (l)	26,025	26,025	26,025	26,035
Normal operating speed (Mach)	0.785	0.785	0.785	0.785
Max cruising altitude (ft)	41,000	41,000	41,000	41,000
Landing field length (m, sea level/ISA)	1,340	1,415	1,634	1,704
Accommodation (1-class)	132	171	189	189
Accommodation (2-class)	108	146	160	177
Design range with pax	5,650km/110	6,040km/126	5,440km/162	5,080km/177

The FAA requires fleet-wide replacement of the 737's rudder system, with the redesign made mandatory for future 737s coming off Boeing's production line (see 737-100/200 entry). Boeing has been shipping wiring kits for 737 Classics since February. Deliveries of hardware retrofit kits for the 737 Classic will begin in the third quarter of next year.

Delivered: 1,988 (Classic)

In service: 1,968 (Classic)

737-600/700/800/900

The Next Generation 737 models were developed from the -300/400/500 family, incorporating a 25% larger wing, new CFM56-7 engines, higher cruising speeds, greater range and a new 777 style flight-deck. Four basic variants seating 108 to 190 passengers have been developed.

The -600 is the smallest and replaces the -500, while the -700 takes over from the -300 and the -800 succeeds the -400. While the -600 and -700 are the same size as the models they replace, the -800's fuselage is 2.8m longer than that of the -400. The -900 is the most recently developed model, and has a 2.6m stretch over the -800. It can seat up to 177 passengers in a two-class layout, but requirements for emergency exits mean the aircraft's maximum seating cannot go beyond the 737-800's 189 seats.

Boeing flew the first -700 in February 1997. Deliveries began to launch customer Southwest in December 1997. JAA certification was achieved in February 1998 after the European body approved a revised emergency exit design to meet its more stringent evacuation requirements.

The first -800 was delivered to Hapag-Lloyd in April 1998 and Scandinavian Airlines (SAS) took delivery of the first -600 in September 1998. The -900 is the latest derivative and deliveries to launch customer Alaska Airlines began in May last year.

Boeing has developed a longer-range -900X version, but has not yet secured a launch customer. The 737-900X, which has an MTOW increased to

83,700kg, can seat up to 220 passengers if airlines opt for an extra pair of Type I doors aft of the wing. Seating capacity at a standard 30in pitch is 201. Service entry is targeted for June 2005.

A passenger/cargo convertible 737-700C featuring a 3.4 x 2.1m side cargo-door has been developed for the US military and entered service earlier this year. Last year, Saudi Aramco, based in Dharan, Saudi Arabia, became the first civil operator of the 737-700QC. It is used as a corporate shuttle and freighter.

A dedicated business jet version of the 737-700 has been developed called the Boeing Business Jet (BBJ). Delivery of a larger BBJ2 version using the -800 fuselage began last year. A 48-seat BBJ was introduced by Lufthansa in June on business class-only services between Düsseldorf and New York Newark. The aircraft is operated by Geneva-based PrivatAir, replacing a flight operated with a mixed cabin Airbus A340.

The APB joint venture provides winglets for both BBJs and commercially operated 737NGs. They were certificated on the BBJ in September 2000 and received approval on commercially operated 737-800s in early 2001, with Hapag-Lloyd the first airline to fly a winglet-equipped 737-800. Winglets are offered both on new build 737-800s and for retrofit and are also available on the -700.

The FAA is implementing a requirement for a fleet-wide replacement of the 737's rudder system, with the redesign made mandatory for future 737s coming off Boeing's production line (see 737-100/200 entry). Boeing has been shipping wiring kits for the 737NG since July. Deliveries of hardware retrofits will begin in the second quarter of next year. Production deliveries of 737NGs with the new rudder system will begin in January.

The 737NG is used as the platform for several surveillance aircraft, including the BBJ-based airborne early warning and control (AEW&C) version (ordered by Australia and Turkey), and the proposed US Navy Multi-mission Maritime Aircraft (-700 or -800).

Production

The 737NG models are built at Boeing's Renton plant near Seattle, Washington. Boeing delivered 299 737s last year. Output has averaged around 20 aircraft a month this year.

Ordered: 2,035 (NG, including 75 BBJs)

Delivered: 1,193 (NG including 66 BBJ)

747-100/SP/200/300

Pan American Airways launched what was then the world's largest airliner in July 1966 with an order for 25 747s. The first aircraft flew in February 1969 and Pan Am introduced the original P&W JT9D-powered 747-100 into revenue service between New York and London in January 1970.

A heavier, longer-range version, the -200 series, entered service in January 1971 and eventually became available with a choice of three powerplants: the P&W JT9D, GE CF6-50 and R-R RB211-524. Significant numbers of 747-200s were delivered as combis and pure freighters.

The long-range, shortbodied 747SP (Special Performance) was introduced in 1976, although total production only amounted to 45 aircraft. The -300, the first derivative to have an extended upper deck, was put into operation by Swissair in early 1983. Many early 747s have been bought by cargo operators and converted into freighters. The last "Classic" 747 was built in 1991.

On 25 May this year, a China Airlines (CAL) 747-200 crashed after breaking up in mid-air as the aircraft approached FL350. One theory being pursued by Taiwan's Aviation Safety Council (ASC), which is leading the investigation, is that the aircraft suffered a rapid depressurisation initiated by metal fatigue. Wreckage from the rear fuselage is believed to show evidence of pre-existing fatigue cracks.

In October, Japan Airlines (JAL) contracted Boeing to upgrade the avionics of its 747-200s and -300s to ensure the aircraft can continue operating in "preferred" European and Pacific region airspace. The modifications enable 747 Classics to be compliant with future air navigation system (FANS-1) and forthcoming European required navigation performance (RNP) standards.

Installation, flight testing and certification of the new avionics on the first JAL aircraft is due to be completed by May 2003.

Earlier this year, GE launched a hot section upgrade for the 747-200/300's CF6-50 engine, following a \$100 million contract from Air France. The carrier ordered the retrofit of up to 106 engines. GE predicts the kit will give up to 25% improvement in time on wing and better exhaust gas temperature margin.

CMC Electronics (formerly BAE Systems Canada) received an STC in 1999 for an upgrade to extend the life of 747 Classics through the addition of communications, navigation, surveillance/air traffic management (CNS/ATM) equipment. Honeywell and Boeing have proposed a glass cockpit 747 Classic retrofit, which would retain the flight engineer's position but provide a dual rating with the two-crew -400 model.

In 1998, KLM became the first operator of the freighter-converted version of the stretched-upper-



A number of customers are taking delivery of Next Generation 737s equipped with blended winglets, including Qantas, which has 15 -800s in service

deck (SUD) 747, which was one of two 747-200SUD combis converted into special freighters by Boeing.

APB has dropped plans to offer a winglet retrofit programme for the 747 Classic, despite flight-testing the devices in 2000. The design will now form the basis for a 747-400 winglet retrofit programme.

A GE CF6-50E2 re-engining programme is offered for the 747 Classic and was launched in 1999 by Atlas Air with a contract for the modification of two P&W JT9D-7J-powered 747-200s.

Delivered: 724
In service: 515

747-400

First flown in April 1988, this advanced, longer-range 747 derivative entered service with Northwest Airlines in January 1989. The -400 uses the -300's fuselage, but has a two-crew digital flightdeck, numerous aerodynamic enhancements and upgraded engines. Wingspan is increased by 4.9m over the Classic. Features include winglets, compos-

ite materials and an optional fuel tank in the horizontal stabiliser. The -400 is available in combi and freighter configurations. The -400D was designed for short routes in Japan's domestic market and lacks the extra wing-span and winglets, but the -400D can be modified easily to -400 standard.

A full freighter version of the -400 entered service with Cargolux in 1993. The aircraft retains the short upper deck of the earlier 747 models and constitutes a large proportion of new 747 deliveries.

An extended range derivative of the 747, the -400ER, was launched in late 2000 following a six-aircraft order from Qantas. The aircraft has a MTOW of 412,770kg and increased fuel tankage providing a further 800km range or an additional 6,800kg payload. The landing gear and some fuselage frames, floor beams and skins are strengthened. The aircraft also features improved flightdeck avionics, with Rockwell Collins liquid crystal displays.

The first 747-400ER flew on 31 July this year and this and one other -400ER have been involved in the three-month, 275h flight-test programme. FAA certification was completed in October, with deliveries to Qantas following. Two of five freighter versions of the 747-400ER ordered by ILFC have been placed with Air France, the first of which has been delivered.

The prospects of an early launch of a 747-400 freighter conversion programme have improved following the drop in used values for the aircraft. Boeing has been studying an in-house conversion programme for several years and is gearing up to a launch. It aims to have partners signed up by the end of the year and is slashing the sticker price from \$30 million to the "low \$20 millions".

Meanwhile, IAL and Korean Air Aerospace (KAL's manufacturing arm) are considering the launch of their own 747-400 freighter conversions.

APB flight tested winglets for the 747 Classic on a -200 in 2000, but has realigned its design study on the -400 variant. Initial retrofits could start in the third quarter of 2004 if the programme goes ahead. Two alternatives are being considered, one which would replace the 747-400 winglets but maintain their wing-span at 64.3m, and the other which would involve adding a wingtip extension to the

BOEING 747 CLASSIC FAMILY				
	-200B	-200F	-300	SP
Length (m)	68.6	70.7	70.7	56.31
Wingspan (m)	59.64	59.64	59.64	59.64
Height (m)	19.6	19.6	19.6	19.94
Wing area (m ²)	511	511	511	511
Cabin width (m)	6.13	6.13	6.13	6.13
Max take-off weight (kg)	351,535	351,535	351,535	299,370
MTOW option	378,200	378,200	378,200	316,000
Max landing weight (kg)	255,825	286,000	260,370	204,115
Option	286,000	-	340,50	-
Operating empty weight (kg)	171,460	155,130	174,040	141,935
Max zero fuel weight (kg)	238,815	267,620	242,680	186,140
Max payload (kg)	67,360	112,490	68,630	38,013
Powerplant	4 x 52,500lb GE CF6-50E or 4 x 45,570lb P&W JT9D-7 or 4 x 50,110lb R-R RB211-524	4 x 52,500lb GE CF6-50E or 4 x 45,570lb JT9D-7 or 4 x 50,110lb RB211-524	4 x 52,500lb GE CF6-50E or 4 x 45,570lb JT9D-7 or 4 x 50,110lb RB211-524	4 x 48,000lb P&W JT9D-7 R-R RB211-524B
Standard fuel capacity (l)	198,380	198,350	198,380	178,700
Normal operating speed (Mach)	0.85	0.85	0.85	0.85
Max cruise speed (kt)	507	507	507	529
Max cruising altitude (ft)	45,100	45,100	45,100	45,100
Take-off field length (m)*	3,190	3,322	3,322	2,165
Landing field length (m)*	1,890	2,112	1,905	1,705
Accommodation (1-class)	490	-	580	400
Accommodation (2-class)	423	-	-	331
Accommodation (3-class)	366	-	400	-
Design range	9,250km	-	10,360km	9,805km
Option	10,660km	-	-	11,000km
with pax	452	-	452	331

Note *sea level/ISA

Directory: world airliners

outer wingbox and increasing the span to around 66.1m. APB estimates block fuel savings over the current 747-400 of around 4% from the modification based on the initial -200 results. The company hopes to launch the programme next year.

Production

Final assembly takes place at Boeing's Everett, Washington, plant. Thirty-one aircraft were delivered last year. The rate is running at around two a month, down from the mid-1998 peak of five a month.

Ordered: 632

Delivered: 587

747-400X QLR

In the wake of the cancellation of Boeing's 747 Stretch plans last year (see entry), a simpler follow-on 747-400 derivative is being proposed. Details of the project, which is in the pre-launch stage, were unveiled in February. Dubbed the 747-400X Quiet Longer Range (QLR), the aircraft features aerodynamic changes, increased weights, more powerful, acoustically treated engines and a new interior. Passenger and freighter versions are offered.

Boeing planned to launch the new model in June, to allow an entry into service in the first half of 2004, but slow market conditions and uncertainty over noise compliance guarantees have caused a delay.

The design features new MTOW of 417,800kg, a modified wing with a new raked wingtip and a trailing-edge wedge on new outboard double-slotted flaps, which combine to improve aerodynamic effi-



The -400ER is the latest version of the 747 and began its short flight-test campaign in August

ciency and provide a 1-2% reduction in specific fuel consumption. Initial plans called for the aircraft to be equipped with derivatives of the 747-400's GE CF6-80C2 and P&W PW4000.

As first proposed, the QLR would offer 3% more range than the current 747-400 at take-off weights up to 396,900kg and comply with stringent QC2 departure noise limits at London Heathrow. However, the initial proposal could not meet these limits at the new MTOW, although it would have between 5% and 15% more range.

A key demand of many of the QLR's potential customers was QC2 noise compliance at the higher operating weight. As this could not be achieved with

the derivative engines, the programme has been delayed and Boeing has decided to broaden the programme to include the 63,000lb-thrust R-R Trent 600 in its design studies.

Boeing is now making further refinements to the QLR's configuration to provide extra range and a marginal increase in capacity without affecting the demand for stringent QC2 noise compliance at London Heathrow. With airlines wanting 14,800km range to ensure economical non-stop flights between the US East Coast and Asia, changes would include the addition of up to 3,790 litres of fuel to an expanded horizontal stabiliser fuel tank and a new fuel tank housed in the vertical fin. The fuselage forward of the wing leading edge would be stretched by 2m or four frames, to offset the shift in centre of gravity while providing space for an extra row of business class seats and extra lower deck cargo.

Prospective customers include Cargolux, Cathay Pacific Airways, Korean Air, Qantas and Singapore Airlines. The latter has been offered a 250-seat version of the QLR in an attempt to overturn its selection of the Airbus A340-500 for ultra-long-haul transpacific routes. Reducing the capacity of the QLR from 416 seats to 250 seats would extend the aircraft's range to 15,840km, making it a viable on routes such as Singapore-Los Angeles.

747 Stretch proposals

Plans for a family of major 747 stretch derivatives were abandoned in April last year as the manufacturer unveiled the Sonic Cruiser project. The 747X

BOEING 747-400 FAMILY

	-400	-400ER	400F
Length (m)	70.7	70.7	70.7
Wingspan (m)	64.4	64.4	64.4
Height (m)	19.41	19.41	19.41
Wing area (m ²)	541.16	541.16	541.16
Cabin width (m)	6.13	6.13	6.13
Max take-off weight (kg)	363,200	412,780	396,900
Option	396,900		412,780**
Max landing weight (kg)	260,360	295,740	295,740
Option	295,740		-
Operating empty weight (kg)	181,120	183,840	164,020
Max zero fuel weight (kg)	251,740	251,740	276,700
Max payload (kg)	70,620	67,900	112,670
Powerplant	4 x 57,-63,000lb GE CF6-80C2B	4 x 63,000lb GE CF6-80C2B5F	4 x 57,-63,000lb GE CF6-80C2B5F
	or 4 x 57,-63,000lb PW4056/4062	or 4 x 63,000lb P&W PW4062	or 4 x 57,-63,000lb PW4056/4062
	or 4 x 56,-59,300lb RB211-524G-T/H-T	or 4 x 59,300lb RB211-524H-T	or 4 x 56,-59,300lb RB211-524G-T/H-T
Standard fuel capacity (l)	204,340	228,250	203,515
Option	216,840	241,140	-
Normal operating speed (Mach)	0.855	0.855	0.855
Max cruise speed (kt)	507	507	507
Max cruising altitude (ft)	45,100	45,100	45,100
Take-off field length (m)*	3,018	3,322	3,078
Landing field length (m)*	2,179	2,179	2,240
Accommodation (1-class)	660	660	-
Accommodation (2-class)	524	524	-
Accommodation (3-class)	416	416	-
Design range	11,440km	13,875km	8,230km
Option	13,430km	14,200km	9,200km**
with pax	416	416pax	113t payload

Note *Sea level/ISA ** - 747-400ERF

BOEING 747-400X QLR

Length (m)	70.7/72.7*
Wingspan (m)	68.7
Maximum take-off weight (kg)	417,800
Standard fuel capacity (l)	248,700/252,500*
Accommodation (3-class)	416/427*
Design range (km)**	13,900
Option ***	14,920
Option****	15,840
Normal operating speed (Mach)	0.86

Notes * Stretched proposal (estimate) ** (at QC2 compliance) *** 416 pax/396,900kg MTOW **** 250pax/417,800kg MTOW. Data for baseline aircraft based on GE CF6-80C9F engine. Freighter version has MTOW of 412,800kg, maximum range of 9,530km with payload of 112,800kg

family would have featured a new wingbox and 2.6m-span wing inserts. The first version was to be the 747X Stretch, featuring forward and aft-fuselage extensions to increase three-class capacity to 504-520 passengers. Powerplant candidates included the GE-PW Engine Alliance GP7000 and R-R Trent 600, and service entry was destined for the second half of 2005. A 150t payload freighter was also proposed, as well as a smaller, ultra-long-range variant – the 430-seat 747X – which eliminated the fuselage extensions.

An early 747 stretch study was dropped in January 1997. These two major 747 derivatives, the -500X/600X, were cancelled after it was decided that the market was too small.

757

The original 757-200 model was launched into production in August 1978 on the back of commitments from BA and Eastern Airlines. After initially sharing commonality with its narrowbodied predecessor, the T-tailed 727, the design was refined to incorporate a low-set tail configuration and new nose, enabling cockpit commonality with the widebodied 767.

The first 757 flew in February 1982 and Eastern introduced the type into service in January 1983. The aircraft is available with R-R RB211-535E4 or P&W PW2000 engines. Combi- and full-freighter "PF" (package freight) versions of the aircraft have also been developed.

The stretched 757-300 derivative was introduced in March 1999, with a 7.1m longer fuselage boosting two-class accommodation to 243 passengers.

Initial -300s were powered by the RB211, but a PW2000-powered version is now available and received FAA certification in June. Northwest Airlines took delivery of the first of 16 examples the following month.

The US Air Force operates a VIP version of the 757-200 designated the C-32A, the first of which was delivered in 1998.

Boeing has for some time been studying an extended-range derivative of the 757-200, called the -200ERX, which will incorporate the strengthened wing and components of the -300 and increased fuel tankage. The aircraft would offer a 650km increase in range.

Boeing's 757-200 Special Freighter cargo conversion was launched in October 1999, on the back of an order from DHL for 44 conversions. Deliveries of the first modified aircraft began in 2000.

Two cargo conversions for the 757-200 are being developed independently, one by Alcoa Aerospace/Structural Integrity Engineering (SIE) and the other by Precision Conversions.

Alcoa has teamed with specialist engineering company SIE, the latter having designed and engineered the conversion. Negotiations are being finalised with an undisclosed launch customer.

UK maintenance company ATC Lasham will undertake the modifications, the first starting in January. This is expected to be certificated for delivery to the launch customer in September next year.

Precision, a joint venture, was formed last year by Wagner Aeronautical. The Erickson Group is refining and validating a finite-element model to provide a

design basis for the conversion. Work on the first aircraft is due to start before the end of the year, with flight tests beginning by mid-2003. Aviation Management Systems of Goodyear, Arizona, will modify and certificate the first conversion. Precision claims it has several offers before potential launch customers and expects to have orders by mid-2003.

SIE's sticker price of \$4.5 million is believed to be similar to that asked by Precision, and around \$4 million lower than Boeing's.

APB has been working on the design of a blended winglet for the 757. A Boeing Business Jet (BBJ) version of the 757 has also been studied.

It emerged earlier this year that Boeing was putting maximum effort into sales campaigns for the 757 as its order backlog dwindled to an all-time low of 36 aircraft. The manufacturer is considering production changes in an effort to ride out the order drought. Although this year's production supports a rate of almost 2.5 aircraft a month, the current backlog for 2003 deliveries will hit an all-time low of 15 aircraft unless new orders are obtained, or delivery positions brought forward. Without these changes, this would cut the rate to around 1.25 a month.

Production

Final assembly of the 757 is undertaken at Renton, Washington. Forty-five aircraft were delivered in 2001 and the production rate is running at around three a month.

Ordered: 1,050

Delivered: 1,018

767

Launched in July 1978, the 767 was Boeing's first widebodied twinjet. Three distinct versions of the aircraft are in service, offering seating from 200 to 300 passengers, as well as a freighter. But efforts to

launch a longer range version of the newest model came to nothing earlier this year when the project was dropped.

The 200/220-seat -200 was the first 767 version, which flew in September 1981 and entered service with United Airlines in August 1982. Initial versions of the 767 were powered by the P&W JT9D and GE CF6, with some later models equipped with the PW4000 or R-R RB211.

The longer-range -200ER entered service with Ethiopian Airlines in May 1984, and the 6.4m longer 269-seat (two class) -300, was certificated in September 1986. American Airlines was the first to operate the extended-range -300ER, in February 1988. The first 767-300 Freighter was delivered to UPS in October 1995.

A further stretched derivative, the -400ER, entered service with Delta Air Lines and Continental Airlines in August 2000. Stretched a further 6.4m, the largest 767 variant can seat 304 passengers in a two-class layout. It features increased operating weights, aerodynamic improvements including increased wingspan, and a new raked wingtip design. The aircraft also features an upgraded flightdeck with Honeywell-developed LCDs, based on the cockpit of the 737NG/777.

A longer-range 767-400ERX model was proposed to compete head-on with the Airbus A330-200, but this project was stopped in March last year along with the 747 Stretch as part of Boeing's Sonic Cruiser announcement. The company says all efforts to develop a longer-range 767-400ER model have been suspended given market uncertainties and the lack of a suitable engine.

During 2001, Boeing launched a study into a 12,300km-range version of the -300ER featuring a fuel tank in the horizontal tail. However, it emerged

BOEING 757 FAMILY

	-200	-200F	-300
Length (m)	47.32	47.32	54.5
Wingspan (m)	38.05	38.05	38.05
Height (m)	13.6	13.6	13.6
Wing area (m ²)	185.25	185.25	185.25
Cabin width (m)	3.54	3.54	3.54
Max take-off weight (kg)	99,880	115,660	123,600
MTOW option	115,660	-	-
Max landing weight (kg)	89,900	95,250	101,800
Option	95,250	-	-
Operating empty weight (kg)	58,390	51,060	63,650
Max zero fuel weight (kg)	84,360	90,710	95,250
Max payload (kg)	25,970	39,800	31,600
Powerplant	2 x 40,080lb P&W PW2040	2 x 40,080lb P&W PW2040	2 x 43,070lb R-R RB211-535E4B
	or 2 x 43,070lb R-R RB211-535E4B	or 2 x 43,070lb R-R RB211-535E4B	or 2 x 42,580lb P&W PW2043
Standard fuel capacity (l)	43,490	42,680	43,400
Normal operating speed (Mach)	0.8	0.8	0.8
Max cruise speed (kt)	505	513	505
Max cruising altitude (ft)	42,000	42,000	41,000
Take-off field length (m, sea level/ISA)	2,377	2,095	2,550
Landing field length (m, sea level/ISA)	1,544	1,497	1,750
Accommodation (1-class)	224	-	279
Accommodation (2-class)	201	-	243
Design range with pax/payload	5,550km/186	7,240km/39.8t	6,410km/243
Option with pax	7,400km/186	-	-

Directory: world airliners



Alitalia is one of the latest customers to take delivery of the 777-200ER, receiving the first of six aircraft it has on order in August

earlier this year that Boeing was focusing its -300X studies on "mission-specific" changes for improved efficiency and lower operating costs instead of increased range. The shift in emphasis follows a strategy review after 11 September.

The revised -300X has a version of the raked wingtip developed for the -400ER, but unlike earlier proposals, is being studied with optional wingtip kits that can be swapped by the airline to tailor the aircraft for certain routes.

Under the plan, a -400ER-type raked tip would be installed for short- to medium-range routes up to around 5,550km. For longer-range missions, however, the tip would be replaced with a smaller raked unit, or the standard "close-out" tip to avoid exceed-

ing wing-load limits with full fuel at take-off.

According to Boeing, the plan would give operators the benefit of the new raked tip without carrying extra weight. The devices, which weigh around 67kg apiece, are expected to generate a saving of around 2% on routes as short as 2,775km, says Boeing. APB, meanwhile, is studying 767-200/300 winglet retrofits and plans to have a proof-of-concept flight test under way as early as the second quarter of 2002.

In early 2002, IAI became the first company to launch a cargo-conversion programme for the 767, following deals with US express cargo carrier Airborne Express and leasing giant GECAS. Boeing lost out on the deal as its proposal was too costly.

The manufacturer has completed design work on a Special Freighter (SF) conversion and has been looking to reduce the price below the quoted \$11 million. Boeing is teaming with Aeronavali to launch its own programme before the end of the year. The Alenia subsidiary would carry out the work at its plants in Venice and Naples. The SF will use the 2.7 x 3.4m forward freight door designed for the new-build -300F model.

Boeing has been selected to supply a tanker version of the 767-200ER to the US Air Force and expects to finalise a lease deal for 100 tankers by the end of the year. Last year, Italy ordered four 767 tanker-transporters, with options for a further two, for delivery from 2004. The type has been selected by Japan and is also being evaluated for the UK Royal Air Force.

A multirole command and control version of the 767-400ER is also planned for the US military. The two 767 models for the US military will share commonality, meaning that the -200ER-based tanker will incorporate the -400's 777-based glass cockpit.

Production

The 767 is assembled at Everett, Washington. A total of 40 aircraft were delivered last year and production is running at around three aircraft a month.

Ordered: 934

Delivered: 885

777

The October 1990 launch of the 777 was Boeing's challenge to the Airbus A330/A340 and the then MDC MD-11. Two sizes are in production – the baseline 300- to 375-seat -200 and the stretched 370- to 450-seat -300.

The -200 was the first version to fly, in June 1994, and United Airlines put the type into service in June 1995. Offered with all the "big three" engines, an intermediate growth variant, the -200ER, was put into service by BA in February 1997.

The larger -300 model entered service with Cathay Pacific in May 1998. The -300, 10m longer than the -200, was aimed at the 747 Classic replacement market.

After several false starts, Boeing launched its new 777X family in February 2000 after concluding an exclusivity deal with GE for the GE90. Based around the two existing models, the new versions

BOEING 767 FAMILY

	-200ER	-300ER	-300F	-É400ER
Length (m)	48.51	54.94	54.94	61.37
Wingspan (m)	47.57	47.57	47.57	51.92
Height (m)	15.85	15.85	15.85	18.79
Wing area (m ²)	283.3	283.3	283.3	290.7
Cabin width (m)	4.72	4.72	4.72	4.72
Max take-off weight (kg)	179,170	184,800	185,200	204,120
MTOW option	-	186,880	186,880	-
Max landing weight (kg)	136,080	136,200	147,870	158,760
Option	-	145,150	-	-
Operating empty weight (kg)	84,000	90,540	85,190	102,010
Max zero fuel weight (kg)	117,930	133,810	140,160	149,680
Max payload (kg)	33,240	43,270	54,970	46,990
Powerplant	2 x 62,020lb GE CF6-80C2B7F or 2 x 52-63,000lb P&W PW4000	2 x 56,-62,000lb CF6-80C2B or 2 x 57-63,000lb PW4000 or 2 x 60,670lb	2 x 62,020lb CF6-80C2B7F or 2 x 63,140lb PW4062	2 x 62-63,500lb CF6-80C2B or 2 x 63,140lb PW4062
	-	R-R RB211-524G/H	-	-
Standard fuel capacity (l)	91,380	91,380	91,380	91,380
Normal operating speed (Mach)	0.8	0.8	0.8	0.8
Max cruise speed (kt)	492	-	-	-
Max cruising altitude (ft)	43,100	43,100	43,100	43,100
Take-off field length (m)	2,620	2,713	-	3,383
Landing field length (m)	1,524	1,876	1,707	1,859
Accommodation (1-class)	274	328	-	375
Accommodation (2-class)	224	269	-	304
Accommodation (3-class)	181	218	-	245
Design range	12,300km	11,400km	5,950km	10,440km
with pax/payload	181	218	54t	245

Note *Sea level/ISA

use the new 115B version of the GE90, and incorporate an increased-span wing incorporating 767-400-style raked wingtips.

The lead aircraft is the -300ER, powered by the GE90-115B rated at 115,000lb thrust – the world's most powerful turbofan. The -200LR's engine will be derated to 110,000lb thrust for the -200LR.

The first -300ER is due to roll out this month, with its maiden flight set for early January. First delivery was scheduled for September next year, but Boeing has pushed this back by six months to March 2004. It is restructuring the test programme around the revised schedule, with the number of -300ER test aircraft cut from three to two. Certification will slip from September next year to late November/early December.

Originally, the -200LR's development was expected to lag around six months behind that of the -300ER, but it has been postponed by 18 months because of "economic conditions" in the wake of the US terrorist attacks in September last year. Boeing plans to start design activity in the second quarter of 2003, and the aircraft is being offered for July 2005 delivery.

Meanwhile, the GE90-115B made its first flight on board GE's 747 flying test bed in September. FAA and JAA certification is scheduled by the end of this year.

Boeing is studying a freighter version of the 777-200 and Emirates has emerged as a potential customer. The Dubai-based airline is pushing Boeing to offer a cargo version of the twinjet to meet its need for an intermediate widebody freighter.

Production

The 777 is built at Everett, Washington, and 61 aircraft were delivered in 2001. Production peaked at seven a month during 1998 and is now running at around five a month.

Ordered: 607

Delivered: 418

Sonic Cruiser

It is 20 months since Boeing's Sonic Cruiser emerged publicly, but the project looks further away from a launch decision than ever. The high subsonic speed transport studies were unveiled in March last year, coinciding with Boeing's decision to shelve plans to develop the 747X and longer-range 767-400ER.

Designed to fly at speeds up to Mach 0.98, the Sonic Cruiser had been a secret design effort by Boeing using the study name project Glacier. When launched, the aircraft's proposed entry into service was the "2006-08" timeframe, but this is now slipping as the manufacturer struggles to generate enough market interest, despite promising a 15-20% reduction in journey times compared to existing aircraft.

Many potential customers have voiced their preference for a more conventional alternative (see *project Yellowstone*). The manufacturer plans to gather potential launch candidates by the end of this year in its efforts to secure board authority to offer the high-speed airliner in early 2003. This had been planned for the last quarter of this year, but has been delayed by the uncertainty over demand.

Initial studies focused on a twin-aisle variant seating 225-250 passengers, although smaller and larger variants are also in the mix. It had been planned that the twin-engined aircraft would use 777-200/300 powerplants to shorten the design cycle, but Boeing has now acknowledged that it will need an all-new engine, due to the different relationship of climb thrust to take-off thrust.

The design cruise speed is Mach 0.95 to 0.98, at altitudes of 40,000-50,000ft. This would reduce flight times by more than 1h for every 5,000km flown, cutting transatlantic trip times by more than 2h and transpacific flights by more than 3h.

An airline working group is providing input to the design and is believed to include American Airlines, All Nippon Airways, BA, Cathay Pacific, Japan Air Lines, United Airlines and Singapore Airlines.

The baseline Sonic Cruiser study is configured with an aft-mounted double-delta, or "cranked arrow", wing combining a high-speed inboard section and a high aspect-ratio outboard section, and could incorporate canards on the forward fuselage. A more conventional mid-wing layout is also being studied.

Boeing has evaluated 25 different wing shapes, more than 30 nacelle configurations and over 60 fuselage iterations. Structural tests are also being carried out on a sample 75%-scale, 6m-long representative fuselage section made of composites. Boeing says that high- and low-speed windtunnel tests have proved the Sonic Cruiser concept.

Boeing has formed a technology development team working on advanced materials for the Sonic Cruiser, which comprises Alenia Aeronautica, Boeing Canada Technology, Boeing Wichita, Fischer Advanced Composite Components, Fuji Heavy Industries, GKN Aerospace Services, Kawasaki Heavy Industries, Japan Aircraft Development, Mitsubishi Heavy Industries, Stork Fokker Aerostructures and Vought Aircraft Industries. Engine partners include GE, P&W and R-R.

Project Yellowstone

This is the codename given to Boeing's high-technology, conventionally configured reference aircraft to the Sonic Cruiser studies. Many potential Sonic Cruiser customers are favouring concepts that push economy rather than speed, and this aircraft could yet emerge as Boeing's next all-new airliner programme in place of the Sonic Cruiser.

Yellowstone is an environmentally optimised conventional 250-seat design with performance in the Mach 0.80 to 0.82 speed range. The concept has attracted interest from carriers in the Sonic Cruiser advisory group, such as BA, which advocate the use of advanced technology to drastically reduce the operating costs of conventional designs rather than increase speeds. Boeing says there is "no time-frame" for the project.

BWB studies

Boeing Phantom Works is studying a range of potential blended wing body (BWB) family variants. These include passenger aircraft in the 200- to 550-seat size, with cruise speeds of up to Mach 0.95 envisaged.

BOEING 777 FAMILY

	-200ER	-200LR	-300	-300ER
Length (m)	63.73	63.73	73.86	73.9
Wingspan (m)	60.9	64.8	60.9	64.8
Height (m)	18.51	18.58	18.49	18.56
Wing area (m ²)	427.8	436.8	427.8	436.8
Cabin width (m)	5.87	5.87	5.87	5.87
Max take-off weight (kg)	263,080	322,055	263,080	317,520
MTOW option	297,560	340,200	299,370	340,200
Max landing weight (kg)	213,190	223,170	237,680	251,290
Operating empty weight (kg)	141,205	155,580	155,500	169,235
Option	143,835	156,035	158,480	-
Max zero fuel weight (kg)	195,045	209,150	224,530	237,685
Max payload (kg)	51,255	50,850	66,050	68,495
Powerplant	2 x 93,700lb GE GE90-94B	2 x 110,000lb GE GE90-110B1	2 x 90-98,000lb P&W PW4090/4098 or 2 x 90,000lb	2 x 115,000lb GE GE90-115B
	or 2 x 84-90,100lb P&W PW4084/4090	-	Trent 892	-
	or 2 x 86,500-93,250lb R-R Trent 884/895	-	-	-
Standard fuel capacity (l)	171,170	195,285*	171,170	181,200
Normal operating speed (Mach)	0.84	0.84	0.84	0.84
Max cruise speed (kt)	499	-	-	-
Max cruising altitude (ft)	43,100	-	43,100	-
Take-off field length (m, sea level/ISA)	3,018	3,170	3,703	3,260
Landing field length (m, sea level/ISA)	1,630	1,675	1,844	1,920
Accommodation (1-class)	440	440	550	550
Accommodation (2-class)	400	400	479	479
Accommodation (3-class)	301	301	368	365
Design range	14,400km	16,420km	11,080km	13,430km
with pax	305	301	368	365

Notes: *Two aux tanks, provision for up to three

Directory: world airliners

Studies include two options for internal modules. One is a mid-size six-abreast configuration, the other is a narrowbody five-abreast arrangement. Each module would seat between 60 and 70 passengers, with flat-panel seatback and wall displays in lieu of windows.

A BWB passenger version could enter service within "seven or eight" years of a launch. A military tanker variant, which is being studied as a potential long-term contender for the US Air Force's KC-X requirement, is seen as the most likely lead into the programme.

Former McDonnell Douglas types (in production)

After Boeing's merger with MDC, all of the latter's current airliner models are marketed under the Douglas Products Division banner. Production of the MD-80/90 and MD-11 was wound up during 2000. In January 1998, the MD-95 was re-designated the 717 to bring it into line with the Boeing nomenclature. The MD-17 commercial version of the Globemaster has been redesignated the BC-17X.

BC-17X (Formerly MD-17)

This is a proposed civil version of the C-17 military airlifter. The market for this 78t-payload, outside freighter is put at 40-50 aircraft.

MD-80

The MD-80 series was developed from the DC-9 twinjet and was in production for 21 years, with 1,191 aircraft being produced. The model also spawned the V2500-powered MD-90. Production of both models ceased in early 2000.

The MD-80 began as the DC-9 Super 80 and the 155-seat one-class (135-seat two-class) basic version, called the DC-9-81 (since renamed the MD-81), entered service with Swissair in September 1980. A similarly sized "hot-and-high" version, the MD-82, entered service in August 1981, followed by the extended-range MD-83, which was certificated in October 1985. The short-fuselage 114-130-seat MD-87 entered service in late 1987, but production ceased in 1992 after 75 had been delivered.

The MD-88 was the last version to be developed. It was dimensionally identical to the MD-81/82/83 and was put into service by Delta Air Lines in January 1988. It has an upgraded cockpit, wider use of composite materials and a redesigned passenger cabin.

Last year, Boeing and R-R had proposed a re-engineering programme for the MD-80 using the 21,000lb thrust BR715 engine, but plans have been suspended following the events of 11 September.

Jet Engineering of California is developing a modified exhaust mixer for the MD-80 to make it compliant with ICAO Chapter 4 noise limits. The company says reduced back pressure from the modified mixer increases the cruise thrust of the JT8D-200 around 500lb, which translates to a specific fuel consumption saving of between 2% and 3% at reduced power settings. The new mixer, weighing around 20kg, adds around 0.15m to the length of the exhaust.

Jet Engineering expects noise levels at take-off to be reduced by 2dB at each measurement point, contributing to an overall cumulative noise reduction totalling 10dB. Certification of the kit is expected by year-end for all MD-80 variants, with kits available in early 2003.

China concluded a licence production deal with MDC in April 1985, which resulted in 35 MD-80s (and two MD-90s) being assembled at Shanghai by SAIC from kits supplied by MDC. The last Chinese assembled MD-80 was delivered in October 1994. SAIC was the prime Chinese contractor and three Chinese companies were involved to produce sub-assemblies - Chengdu Aircraft, Shenyang Aircraft and Xian Aircraft.

BOEING MD-80/90 FAMILY

	MD-81	MD-82	MD-83/88	MD-87
Length (m)	45.1	45.1	45.1	39.75
Wingspan (m)	32.8	32.8	32.8	32.8
Height (m)	9.02	9.02	9.02	9.3
Wing area (m ²)	112	112	112	112
Cabin width (m)	3.14	3.14	3.14	3.14
Max take-off weight (kg)	63,503	67,813	72,576	63,503
Max landing weight (kg)	58,060	58,968	63,277	58,060
Operating empty weight (kg)	37,885	37,925	38,737	35,313
Max zero fuel weight (kg)	53,524	55,339	55,339	50,803
Max payload (kg)	15,644	17,414	16,602	18,211
Powerplant	2 x 19,230lb P&W JT8D-209	2 x 20,890lb P&W JT8D-217A/C	2 x 21,690lb P&W JT8D-219	2 x 20,830lb P&W JT8D-217B/C or 2 x 21,690lb P&W JT8D-219
Standard fuel capacity (l)	22,104	22,104	263,481	22,106
Normal operating speed (kt)	340	340	340	340
Normal operating speed (Mach)	0.76	0.76	0.76	0.76
Max cruise speed (kt/mach)	499	499	499	499
Max cruising altitude (ft)	37,000	37,000	37,000	37,000
Take-off field length (m, sea level/ISA)	2,210	2,271	2,553	1,859
Landing field length (m, sea level/ISA)	1,478	1,500	1,585	1,430
Accommodation (1-class)	168	168	168	139
Accommodation (2-class)	144	144	144	114
Design range with pax	2,897km/155	3,798km/155	4,635km/155	4,395km/130

BOEING MD-11 AND BC-17X

Model	MD-11*	MD-11F***	BC-17X
Length (m)	61.6	61.6	53.04
Wingspan (m)	51.7	51.7	51.74
Height (m)	17.65	17.65	16.79
Wing area (m ²)	339	339	353.03
Cabin width (m)	5.71	5.71	5.49
Max take-off weight (kg)	285,990	285,995	265,350
MTOW option	286,247kg**	-	-
Max landing weight (kg)	207,750	222,944	215,460
Operating empty weight (kg)	132,800	118,386	124,875
Max zero fuel weight (kg)	195,048	209,246	202,937
Max payload (kg)	62,248	90,446	78,600
Powerplant	3 x 60,000lb P&W PW4460 or 3 x 61,970lb PW4462 or 3 x 61,340lb GE CF6-80C2	3 x 60,000lb P&W PW4460 or 3 x 61,970lb PW4462 or 3 x 61,340lb GE CF6-80C2	4 x 40,440lb P&W PW2440
Standard fuel capacity (l)	146,174**	146,174	102,294
Normal operating speed (kt)	510	510	-
Normal operating speed (Mach)	0.83	0.83	0.74-77
Max cruise speed (kt/mach)	511	511	-
Max cruising altitude (ft)	42,000	42,000	45,000
Take-off field length (m, Sea level/ISA)	3,115	3,115	1,165
Landing field length (m, Sea level/ISA)	2,118	2,323	1,196
Accommodation (1-class)	410	-	-
Accommodation (2-class)	356	-	-
Accommodation (3-class)	285	-	-
Design range with pax/payload	12,805km/285	6,700km/88.4t	4,630km/78t
Option	13,340km/298**	-	-

Notes *P&W-powered version ** MD-11ER model with 167,260l fuel *** weights for GE-powered version

Boeing continues engineering work on a potential MD-82 Special Freighter variant, which it sees as a potentially good regional freighter in Asia.

APB is undertaking product definition studies for MD-80 winglets, although any programme will follow developments on Boeing 7-series aircraft.

Delivered: 1,191 (including 35 SAIC-built aircraft)
In service: 1,164 (including 33 SAIC-built aircraft)

MD-90

A slightly stretched, re-engined development of the longbodied MD-80, the MD-90 first flew in August 1993 and entered service with Delta in April 1995.

Powered by IAE V2500-D5 engines, the aircraft also has an upgraded EFIS flightdeck, a redesigned passenger cabin and carbon brakes. Production ended in 2000.

An assembly line was also established in Shanghai, which was to produce the planned MD-90T TrunkLiner. However, before the programme could get into its stride, Boeing took over McDonnell Douglas and the programme. Just two MD-90s were assembled in China, the last being delivered to China Northern Airlines in September 2000.

Delivered: 113 (including 2 MD-90 TrunkLiners)
In service: 113

MD-11

The first MD-11 was flown in January 1990 and Finnair introduced the type into revenue service in December the same year. The tri-jet is essentially a stretched development of the DC-10, equipped with a two-crew flightdeck, and a choice of new generation engines – either the GE CF6-80 or the P&W PW4000.

The 295-seater initially struggled to meet its original performance targets, forcing MDC to introduce aerodynamic and structural changes.

The last variant to be developed, the MD-11ER, exceeded the original specification by being able to carry its specification payload of 298 passengers more than 13,300km. The MD-11 Freighter was introduced by FedEx in May 1991, and Boeing offers an aftermarket cargo conversion.

MD-11 production terminated in 2000 after the 200th aircraft had been completed and the last two aircraft built were delivered to Lufthansa Cargo in early 2001.

Delivered: 200
In service: 195

ILYUSHIN

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In May 2001, the Russian government announced plans for the creation of joint design-bureau/production-plant companies. Ilyushin is grouped in a venture that is led by Sukhoi and includes design bureaux Beriev, Mil, Yakovlev, as well as the Voronezh aircraft factory, where the Il-96 is produced.

Il-62M/MK

Three versions of the four-engined 170- to 195-seat Il-62 were built between 1963 and 1985, before it was



A hushkit and new operating procedures have been developed to reduce the noise levels of the Il-62

superseded by the re-engined Il-62M. All versions were dimensionally identical, the main differences being in engine type, weight and performance.

While the initial production version is equipped with Kuznetsov NK8 engines, the later Il-62M and MK are equipped with the Soloviev D-30KU.

NPO Saturn (formerly Rybinsk Motors), which makes the Il-62M's D-30 engine, is offering a Chapter 3 hushkit for around \$100,000 per aircraft. A new low-emission combustion chamber can also be installed to meet the stricter emission standards due to come into force in 2004.

Meanwhile, Ilyushin has devised performance changes to reduce the Il-62's noise. The design bureau recommends that the Il-62 be operated at reduced take-off weights to enable it to comply with Chapter 3. For operation from European airports, the Il-62 can take off with a reduced fuel load and still carry a full passenger payload.

Il-62 production was undertaken by the Kazan Aircraft Production Organisation.

Delivered: 289

Il-76

Designed to meet the Soviet air force's requirement for a heavy transport aircraft, the first Il-76 was first flown in March 1971 and entered service in 1974.

Different versions of the four-engined, high-winged freighter were produced for Aeroflot and the Soviet military, all powered by MKB (Soloviev) D-30KP engines. Many Il-76s are flown on commercial freight charters.

A 6.6m-stretched version, the Il-76MF, powered by Aviadvigatel PS-90A turbofans, was flown for the first time in August 1995. The new model has a 1.5t increase in payload and the new engines are claimed to offer a 12% reduction in fuel consumption, boosting range by 20%. While the MF is targeted at the Russian air force, Ilyushin hopes to gain civil certification for the civil Il-76TF version by year-end, after the completion of flight testing of the military MF version.

Plans unveiled in 2000 by Tashkent Aircraft Production Plant (TAPO), Ilyushin and CFMI to develop a CFM56-5C4-powered version of the

ILYUSHIN	Il-62MK	Il-76MF	Il-86	Il-96-300	Il-96T
Length (m)	53.12	53.19	59.54	55.35	63.94
Wingspan (m)	43.2	50.5	48.06	57.66	60.11
Height (m)	12.35	14.42	15.81	15.72	15.12
Wing area (m ²)	279.55	300	320	391.6	391.6
Cabin width (m)	3.45	3.45	5.7	5.7	5.7
Max take-off weight (kg)	167,000	200,000	208,000	216,000	270,000
Max landing weight (kg)	110,000	151,500	175,000	175,000	220,000
Operating empty weight (kg)	74,000	101,000	116,250	117,000	116,400
Max zero fuel weight (kg)	97,500	-	158,400	157,000	208,400
Max payload (kg)	25,000	60,000	42,040	40,000	92,000
Powerplant	4 x 24,240lb	4 x 35,250lb	4 x 28,530lb	4 x 35,250lb	4 x 36,980lb
	Aviadvigatel D-30KU	Aviadvigatel PS-90A	Kuznetsov NK86	PS-90A	P&W PW2337
Standard fuel capacity (l)	105,300	109,480	114,000	150,387	150,387
Normal operating speed (kt)	486	459	486	486	-
Max cruise speed (kt/mach)	496	432	512	480	-
Take-off field length (m, sea level/ISA)	3,300	-	3,350	2,600	3,350
Landing field length (m, sea level/ISA)	2,500	-	2,300	1,980	2,400
Accommodation (1-class)	186	-	350	300	-
Accommodation (2-class)	144	-	234	-	-
Accommodation (3-class)	-	-	-	235	-
Design range	-	5,200km	3,600km	7,500km	5,200km
with payload	-	40t	42t	40t	92t

Directory: world airliners

IL-76MF have been stalled due to the lack of a launch customer. The agreement also covered the re-engineing of standard IL-76 airframes.

NPO Saturn is undertaking a \$20 million project to heavily revise the IL-76's D-30KP engine by 2005 to enable it to meet Chapter 4 noise and emissions standards. The changes, which should also reduce fuel consumption by 5-7%, will be retrofittable to an existing engine during overhaul.

Earlier this year, Volga-Dnepr Airlines signed an agreement with engine manufacturer Perm to launch an Aviadvigatel PS-90 re-engineing programme for the IL-76. Aviastar will carry out conversion work at its plant at Ulyanovsk.

Volga will take an upgraded version of the PS-90 that engine design bureau Aviadvigatel and manufacturer PMZ (Perm Motor Plant) are developing. The new engine will be funded by the Russian state aerospace agency Rosaviacosmos and Pratt & Whitney (the parent of which, United Technologies, holds a 25% stake in PMZ).

The enhanced engine, designated the PS-90A2, was to be part of the civil aviation development programme provided commercial funding could be found and the engine is certificated by 2005. The A2 will cost 20% more than the earlier engine, but the design bureau predicts a 40% reduction in life-cycle costs via the introduction of improved components, including some non-Russian items, which will extend the time between overhaul. Improvements will be retrofittable to the earlier model.

Production

Final assembly of the IL-76 is undertaken by TAPO in Tashkent, Uzbekistan. Around 50 completed aircraft are yet to be delivered.

Delivered: c920

IL-86

The IL-86 was the first Russian widebody airliner,

with the initial example flying in December 1976. Powered by four Kuznetsov NK-86 engines, the aircraft entered service with Aeroflot in December 1980. Production ceased in 1994 after 104 aircraft had been built.

Ilyushin says that there is no prospect that Kuznetsov will be able to fund Chapter 3 modifications for the aircraft's NK-86 engines. So the aircraft will have to operate at reduced take-off weights to achieve compliance, which is likely to result in a payload penalty to be marginally compliant with Chapter 3.

Meanwhile, checks were made on the horizontal stabilisers of the entire IL-86 fleet following the crash of a Pulkovo Airlines example after take-off in July. A stabiliser pitch-up caused the crash, but it has not been established why.

Delivered: 104

IL-96-300/400

The IL-96-300 is a short-fuselage, long-range, advanced-technology development of the IL-86, equipped with new engines (PS-90As), a new wing, EFIS flightdeck and a fly-by-wire FCS.

The first prototype was flown in September 1988 and the aircraft was certificated in December 1992.

Design work was initiated by Ilyushin on a 70t payload freighter version of the IL-96-300 in 2000. This was to be developed in conjunction the Voronezh Aircraft Production Association (VASO) and Russian banks.

With the IL-96M/T programme now terminated (see below), the design bureau is undertaking the development of a Russian-engined version of the stretched aircraft, equipped with PS-90s and designated the IL-96-400 (or IL-96TR).

Atlant Soyuz, Russia's fourth-largest cargo carrier, is the first customer for the aircraft. The carrier has an order for up to 10 -400T freighters,

the first two of which will be funded through Ilyushin Finance.

Production

Final assembly is undertaken at the VASO plant in Voronezh, Russia. Output is running at a trickle, but may pick up once production of the IL-96-400 begins.

Ordered: 28 (18 -300/10 -400)

Delivered: 11 (11 -300)

IL-96M and T

The IL-96M/T passenger/freighter widebody is a stretched development of the IL-96-300 equipped with P&W PW2337 engines and Rockwell Collins flightdeck avionics. The prototype IL-96M passenger version flew in April 1992 and the first production-standard aircraft (an IL-96T freighter) in May 1997.

Although basic Russian type certification for the IL-96T was received in March 1998, the much delayed programme was terminated in 2001 after the approved US Exim Bank financing was delayed by a series of political issues.

The prototype IL-96M has since been re-engined with PS-90A engines, effectively becoming IL-96-400 standard.

Production

See IL-96-300/400.

150-seater project

Ilyushin is planning to bid for the Russian government's tender to design a short- to medium-haul, 150-seat aircraft in partnership with Yakovlev and the Irkutsk Aviation Production Organisation. The aircraft would be designed to have a range of around 5,000km.

LOCKHEED MARTIN

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L-1011 TriStar

The first L-1011 TriStar flew in November 1970, and a total of 249 were delivered between 1972 and 1983, when production ceased. Two hundred of these aircraft were "longbody" TriStars (-1, -100 and -200) and 50 were the short-fuselage, extended-range -500s, all powered by R-R RB211s.

Lockheed developed several aftermarket upgrades for the longbody TriStar, which included various weight increases and additional fuel capacity, to improve payload/range performance. An upgrade to -100 specification was available, as well as modification packages that created three new variants (never delivered new) - the -50, -150 and -250.

UK company Marshall Aerospace delivered 12 TriStar 200 freighters, beginning in August 1995, but no further conversions are known to be planned.

Prospects for major upgrades in the longer term are diminishing, as the number of active aircraft has been severely reduced during the economic downturn. Of the 138 that remain in an operational condition, less than 60 are believed to be in active service.

Delivered: 249

In service: 138

LOCKHEED TRISTAR

	L-1011-1	L-1011-100	L-1011-250	L-1011-500
Length (m)	54.17	54.17	54.17	50.05
Wingspan (m)	47.34	47.34	47.34	50.09
Height (m)	16.87	16.87	16.87	16.87
Wing area (m ²)	320	320	320	329
Cabin width (m)	-5.77	5.77	5.77	5.77
Max take-off weight (kg)	195,045	211,375	231,335	231,540
Max landing weight (kg)	162,385	166,920	166,920	166,920
Operating empty weight (kg)	109,633	111,675	113,399	111,312
Max zero fuel weight (kg)	147,417	153,315	153,315	153,315
Max payload (kg)	36,268	41,640	39,916	42,003
Powerplant	3 x 42,020lb -R RB211-22B	3 x 42,020lb R-R RB211-22B	3 x 50,000lb R-R RB211-524B4	3 x 50,000lb R-R RB211-524B4
Standard fuel capacity (l)	89,450	100,100	119,885	119,885
Normal operating speed (kt)	375	375	375	375
Max cruise speed (kt/mach)	520	512	518	518
Max cruising altitude (ft)	42,000	42,000	42,000	42,000
Take-off field length (m)*	2,423	3,292	2,987	2,636
Landing field length (m)*	1,737	1,768	2,042	2,073
Accommodation (1-class)	400**	400**	362	315
Accommodation (2-class)	310	310	310	250
Accommodation (3-class)	280	280	280	233
Design range	5,735km	7,030km	9,410km	9,905km
with pax	310	310	280	250

Notes *sea level/ISA **all Type A exits. 345 pax otherwise.

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There are fewer than 60 TriStars in active service, with Canadian charter carrier Air Transat one of the prime operators

MCDONNELL DOUGLAS

Address – see Boeing

Former MDC types are supported by Boeing's Long Beach plant in California.

DC-8

The first DC-8 flew in May 1958 and the four-engined jet entered service in September 1959. Over 240 of the 556 DC-8s delivered remain in commercial service. Most DC-8s are operated as freighters.

A special purpose company, Cammacorp, was created in 1979 to oversee the CFM56 retrofit programme for the DC-8 Series 60. In total, 110 aircraft were re-engined with CFM56 turbofans and designated the DC-8 Series 70.

Quiet Technology Venture (formerly Quiet Nacelle) has an FAA STC for its DC-8-50 P&W JT3D-3B Chapter 3 hushkit. Burbank Aeronautical II (BAC II) had been developing a Chapter 3 hushkit for the DC-8-50 and -61, which was to have been

virtually identical to that developed for the 707.

However, BAC closed earlier this year after failing to recover from Chapter 11 bankruptcy protection.

Delivered: 556

In service: 228

DC-9

First flown in February 1965, McDonnell Douglas's DC-9 airliner entered service with US carrier Delta Air Lines in December 1965.

The twinjet was produced in five main variants (-10, -20, -30, -40 and -50), with four different fuselage lengths.

The MD-80, which was an evolution of the DC-9, superseded its predecessor in 1981, when production of the original twinjet ceased.

Around 400 DC-9s have been upgraded with ABS Partnership's Stage 3 hushkits.

Delivered: 976

In service: 703

DC-10

The DC-10-10, which was the initial production version of the widebody tri-jet, made its first flight in August 1970. This short/medium-range variant entered service with American Airlines in August 1971. Longer-range derivatives, the GE CF6-powered -30 and P&W JT9D-powered -40, were introduced in November 1972 by Swissair and Northwest Airlines, respectively. The -15, a "hot-and-high" derivative of the -10, was developed for Mexican carriers Aeromexico and Mexicana, and entered service in June 1981. Sixty DC-10-based KC-10 Extender tankers were delivered to the US Air Force.

The MD-10 programme was launched in 1996 by McDonnell Douglas after an agreement with FedEx Express covering the conversion of ex-American Airlines and United Airlines DC-10-10s for use as cargo aircraft equipped with an MD-11-based two-crew cockpit.

MCDONNELL DOUGLAS

	DC-8-63CF	DC-8-73AF	DC-9-30	DC-9-50	DC-10-10	DC-10-30	DC-10/MD-10-30F
Length (m)	57.1	57.1	36.3	40.7	55.5	55.3	55.3
Wingspan (m)	45.2	45.2	28.5	28.5	47.34	50.4	50.4
Height (m)	13.1	13.1	8.38	8.38	17.7	17.7	17.7
Wing area (m ²)	271.9	271.9	112	93	329.8	338.8	339
Cabin width (m)	3.5	3.5	3.14	3.14	5.71	5.71	5.71
Max take-off weight (kg)	161,000	161,000	49,895	54,420	190,504	259,459	263,088
MTOW option	-	-	54,940	-	-	-	-
Max landing weight (kg)	124,850	124,850	45,814	49,885	164,854	182,766	197,770
Operating empty weight (kg)	65,830	67,740	25,400	29,300	111,344	121,563	108,864
Max zero fuel weight (kg)	118,500	118,500	41,730	44,670	151,956	166,924	187,790
Max payload (kg)	49,490	50,760	16,330	15,370	40,612	45,726	73,030
Powerplant	4 x 19,000lb P&W JT3D-7	4 x 22,020lb CFMI CFM56-2C	2 x 14,000-15,500lb P&W JT8D-7, -9, -11 or -15	2 x 15,500/16,200lb P&W JT8D-15/17	3 x 40,000lb GE CF6-8D	3 x 51,-52,500lb GE CF6-50C/C2	3 x 51,-52,500lb GE CF6-50C/C2
Standard fuel capacity (l)	91,890	91,890	13,925	16,120	82,134	138,904	138,730
Normal operating speed (kt)	352	352	350	340	400	356	356
Normal operating speed (Mach)	-	0.88	-	-	0.82	0.82	0.82
Max cruise speed (kt/mach)	522	522	503	501	475	530	530
Max cruising altitude (ft)	42,000	42,000	35,000	35,000	42,000	42,000	42,000
Take-off field length (m, Sea level/ISA)	-	3,048	1,777	2,362	2,625	2,847	-
Landing field length (m, Sea level/ISA)	-	1,981	1,317	1,439	1,720	1,758	-
Accommodation (1-class)	189	-	119	139	380	380	-
Accommodation (2-class)	209	-	105	125	255	270	-
Design range	7,400km	8,950km	2,220km	1,850km	5,370km	10,450km	5,735km
with payload or pax	27.2t	27.2t	12t	14t	27t	27t	78t
Option with payload	-	-	2,940km/12t	-	-	-	-

TUPOLEV/YAKOVLEV

	Tu-154M	Tu-204-100	Tu-204-120	Tu-204-120C	Tu-214	Tu-204-300	Yak-42D
Length (m)	47.9	46.1	46.1	46.1	46.1	40.2	36.38
Wingspan (m)	37.5	42	42	42	42	42	34.88
Height (m)	11.4	13.9	13.9	13.9	13.9	13.9	9.83
Wing area (m ²)	201.5	182.4	182.4	182.4	182.4	182.4	150
Cabin width (m)	3.58	3.57	3.57	3.57	3.57	3.57	3.6
Max take-off weight (kg)	100,000	103,000	102,950	102,950	110,750	103,000	57,000
MTOW option	-	-	-	-	-	84,800	-
Max landing weight (kg)	80,000	89,500	88,200	88,200	-	88,000	51,000
Operating empty weight (kg)	55,300	56,920	59,300	57,460	59,000	-	34,515
Max zero fuel weight (kg)	74,000	83,575	80,300	82,300	84,200	-	-
Max payload (kg)	18,000	21,000	21,000	24,840	25,200	16,000**	13,500
Powerplant	3 x 23,370lb Aviadvigatel	2 x 35,250lb Aviadvigatel	2 x 43,070lb R-R RB211	2 x 43,070lb R-R RB211	2 x 35,250lb Aviadvigatel	2 x 35,250lb Aviadvigatel	3 x 14,310lb Progress
	D-30KU	PS-90A	-535E4B	-535E4B	PS-90A	PS-90A	ZMKB D-36
Standard fuel capacity (l)	41,300	30,812	30,812	30,812	40,730	-	23,330
Normal operating speed (kt)	310	314	314	314	314	-	324
Normal operating speed (Mach)	-	0.83	0.83	0.83	0.83	0.83	0.75
Max cruise speed (kt/mach)	514	458	458	458	458	458	400
Max cruising altitude (ft)	-	41,000	41,000	41,000	41,000	41,000	31,500
Take-off field length (m)*	2,100	2,500	-	-	2,050	2,050	1,500
Landing field length (m)*	2,060	2,130	-	-	2,000	2,000	1,670
Accommodation (1-class)	180	214	214	-	210	166	120
Accommodation (2-class)	146	196	196	-	182	-	104
Accommodation (3-class)	-	190	190	-	170	-	-
Design range	3,700km	4,900km	4,500km	3,500km	4,800km	9,250km	1,900km
with pax/payload	180	21t	210	25t	25t	16t	120
Option with payload	-	-	-	-	-	3,400km/18t**	-

Note *sea level/ISA **18t payload option with lower MTOW

The first phase of the programme began in early 1997 with the conversion of the ex-passenger aircraft to freighters. The freighter conversion involves structural strengthening to raise MTOW to 203t. Phase two of the programme, the installation of the Honeywell advanced common (ACF), received FAA certification in May 2000. A common type rating for the MD-11 and MD-10 was also approved.

FedEx has since decided not to exercise its 30 MD-10 conversion options. However, the carrier remains committed to taking the 89 conversions that it has on firm order by 2006. Around 12 aircraft have been delivered.

Delivered: 446 (including KC-10 tankers)
In service: 343 (including KC-10 tankers)

MD-80, MD-90, MD-11
See Boeing

SATIC

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A300-600ST 'Beluga' Super Transporter

This outsized version of the Airbus A300-600R was developed to replace the ageing fleet of four Aero Spacelines Super Guppy turboprops that were used to transport Airbus subassemblies between the organisation's plants.

Based on a new-build A300-600R airframe, the Beluga has an upward-opening nose-section, a 7.4m-diameter fuselage and a lowered flightdeck structure. An enlarged fin and horizontal-tail endplates improve directional stability. The aircraft has

400m² more volume than the Super Guppy and a 22.5t greater payload capacity. The aircraft was certificated in October 1995 and five aircraft have been delivered to Airbus.

Delivered: 5
In service: 5

TUPOLEV

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Tu-154M

The initial version of the Tu-154 flew in October 1968. Early versions (Tu-154, -154A and -154B-2) are equipped with Kuznetsov NK-8 engines. The Aviadvigatel D-30KU-powered version, the Tu-154M, which was the last production variant, features increased weights and range. Deliveries to Aeroflot began in late 1984, and about 400 have been completed. A cargo conversion, called the Tu-154S, with a large freight-door on the forward fuselage is also in service.

NPO Saturn, which produces the Tu-154M's D-30KU engine, is offering a Chapter 3 hushkit for around \$100,000 per aircraft. A new low-emission combustion chamber is also offered to meet the stricter emission standards that are due to come into force in 2004. Saturn is also undertaking a \$3.5 million programme to bring the D-30KU in line with proposed Chapter 4 standards, which should be completed by 2005.

Production

Assembly of the Tu-154 was undertaken by Aviakor, in Samara, but the production line has closed. It has

enough parts to complete a further 10 aircraft. Five completed aircraft remain to be delivered.

Delivered: 928 (605 A/Bs and 323 Ms)

Tu-204-100/120

Representing Russia's first new technology single-aisle airliner, versions of the Tu-204 twinjet have been delivered with Russian and Western engines. The first example flew in January 1989 and received Russian certification in January 1995. Aeroflot received its first Tu-204, a -204C freighter, in April 1995.

The baseline Tu-204-100 version is powered by Aviadvigatel PS-90 engines and is produced by the Aviastar plant in Ulyanovsk. An enhanced version of the PS-90, the A2, is under development by Aviadvigatel and manufacturer PMZ (Perm Motor Plant). The engine will cost 20% more than the earlier engine, but the design bureau predicts a 40% reduction in life-cycle costs via the introduction of improved components, including some non-Russian items, which will extend the time between overhaul. Improvements will be retrofitable to the earlier model (see *Il-76 entry*).

The westernised version of this model is called the Tu-204-120, and is powered by R-R RB211-535E4Bs. The first example flew in August 1992. Leasing company Sirocco Aerospace was formed by Egyptian company Kato Aromatic to market the R-R-powered aircraft and placed orders in 1996 for up to 30. This model received Russian certification in July 1997 and Egyptian carrier Air Cairo took delivery of the first example in November 1998.

A high-gross-weight version of the Tu-204-120 freighter is being studied, the Tu-204-220. It will

Directory: world airliners

have a strengthened floor, revamped cargo door and no passenger windows, raising payload capacity from the current 25-30t.

Aviastar has completed a Tu-204-120 with a Westernised cockpit, which incorporates altimeters calibrated in feet rather than metres, and instrument inscriptions in English instead of Russian.

The JAA is in the process of certifying the Tu-204-120, using the first aircraft to be equipped with the English language flightdeck. Sirocco is funding the JAA approval process.

Aviastar has orders from two Chinese airlines – China Southwest and China Northwest – for five Tu-204-120C freighters equipped with Westernised cockpits, Honeywell auxiliary power units and radio equipment. Deliveries are due to start early next year. The first English language cockpit Tu-204 will be used in the JAA certification programme before delivery to China.

Shrink versions – the Tu-204-300/500 (see entry) – and a cryogenic fuel (hydrogen) powered variant – the -400 – are also in development.

Production

Series production of the PS-90-powered Tu-204-100 and R-R-powered Tu-204-120 is undertaken by Aviastar at its factory in Ulyanovsk. The Tu-204-300 shrink is also being produced here. Until recently, production at Aviastar has been in limbo as the plant concentrated on completing aircraft already in manufacture. Egypt's Kato Aromatic and Russia's Leader group have agreed to fund the production of 30-50 new aircraft at Aviastar in 2003-05. The plant is controlled by design bureau Tupolev.

Aviastar is expected to build around six Tu-204s this year. This includes two RB211-powered -120C freighters for Sirocco with the balance being PS-90A-powered -100s for Russian airlines.

Ordered: 39 (28 Tu-204-100/11 Tu-204-120)

Delivered: 22 (17 Tu-204-100/5 Tu-204-120)

Tu-204-300/500 (Tu-234)

The Tu-204-300 model (previously the Tu-234) is a shortened, longer-range derivative of the Tu-204 airframe. The first aircraft is about to be rolled out at the Aviastar plant and is due to fly early next year.

This 160-seat model has been under development since the early 1990s. Although Aviastar converted the prototype Tu-204 to Tu-204-300 stan-

dard in 1995, lack of finance meant the aircraft has still not flown.

The aircraft is 6m shorter than the Tu-204 from which it is derived, with the fuselage reduced by 3m forward and aft of the wing. The initial version has an MTOW of 103,000kg, a range of 9,000km and is powered by the improved PS-90A2. Later versions could be developed with R-R RB211-535E4 power.

A lighter, short-range version, with an 89t MTOW, has been studied and would be able to fly 3,400km. A cargo version, the Tu-204-300C/Tu-234C, will also be offered. Being a derivative aircraft, certification of the -300 would require around 150-200 flights during a six-month test programme, after which the development aircraft will be reworked and sold.

An enhanced version, the Tu-204-500, is under development with a new smaller wing and MTOW increased to 105,000kg and is expected to be available by 2005-06. The new wing is optimised for a slightly faster Mach 0.84 cruise speed and Tupolev says it is comparable in characteristics with that of the Next Generation 737.

The design bureau is implementing a weight saving programme to reduce empty weight by 2,000kg.

Versions intended for ETOPS operations will have the Honeywell 331-200ER auxiliary power unit instead of the Russian-built Stupino TA-12A unit.

Production

The Tu-204-300 is produced at Aviastar alongside the Tu-204-100/120.

Tu-214

This is a higher-weight, longer range version of the Tu-204-100 that is built by the Kazan Aircraft Production Organisation (KAPO) in Tatarstan with support from the Tatarstan government. The Russian government is preparing to re-organise the manufacturing industry, which would bring KAPO in to the Tupolev controlled group and make it a partner, rather than a competitor, to Aviastar.

Designated the Tu-214, the baseline PS-90-powered model made its first flight in March 1996. Russian certification was received in December 2000, and Khabarovsk-based Dalavia took delivery of the first aircraft in May 2001.

Last year Sirocco Aerospace reached agreement with KAPO to develop an RB211-powered version of the Tu-214. Until now, Aviastar has been the only

producer of the R-R-powered version of the Tu-204 under an exclusive agreement with Sirocco. KAPO should complete the first RB211-powered Tu-214 within a year.

KAPO is to deliver two Tu-214s to Moscow-based carrier GTK Rossiya, and one more to Dalavia. Atlant-Soyuz and leasing company FLC have signed a letter of intent for three passenger models and two freighters.

Production

The KAPO plant in Kazan produces the Tu-214.

Ordered: 8

Delivered: 3

Tu-234 – see the Tu-204-300/500

YAKOVLEV

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Yak-42

First flown in March 1975, the 120-seat Yak-42 tri-jet entered service with Aeroflot in 1980. The current production model is designated the Yak-42D.

A developed version called the Yak-42A, entered production at Saratov in 1998. The new model has cabin improvements such as drop-down oxygen masks, additional galley equipment, improved seating and enclosed luggage racks, and a larger passenger door, as well as acoustic lining on the engines to reduce noise. The aircraft also has increased wing fuel tank capacity, and new Russian avionics to permit Category 2 operations.

Yakovlev has introduced intermediate positions for the trailing-edge flaps to achieve better field performance in hot-and-high conditions.

The Yak-42D-100 (Yak-142) is a version of the Yak-42D, with a Western avionics suite.

Production

The Yak-42 is built by the Saratov aviation plant in Saratov. Output of the tri-jet is running at a slow rate. In 2000, a group of Russian aviation companies – AT Alliance – proposed to Yakovlev that it should take over the Yak-42 programme and its staff. Discussions have not resulted in any agreement materialising.

Delivered: c175



Engine builder Saturn is working on a \$3.5 million programme to bring the Tu-154M's D-30KU engine in line with Chapter 4 noise limits by 2005

Jurassic birdstrike?

The US Navy is investigating a close encounter with what is reportedly believed to be a young pterodactyl. The unfortunate creature caused almost catastrophic damage when it ploughed into the leading edge of the starboard horizontal tail of the T-44A during a flight from the aircraft's base in Corpus Christi, Texas. Navy spokesman G. Pers-Creepers says: "It seems our anti-Jurassic cloning patrol flights are working. Although we cannot at this time confirm the true species of the creature, it appears to be one that sleeps anywhere it wants and chirps with a real deep voice. We are currently arming the T-44As in case we bump into its mother."

Yuckspeak (series of 1,000,000)

Self-contained in-seat entertainment system = book.



What is this raptor around the leading edge?

In good company

So, Sino-Swearingin's SJ30-2 is finally in flight test and, even better, is accompanied by a supersonic Hawker Hunter Mk 58. A what!? Well that's what it says here. I suppose that would be the Mach 0.93 supersonic Hunter 58 then, would it? Never mind. We asked: if the SJ30 goes Mach 0.83 flat out, why not use a Citation X as a chase instead? It has more windows and you can keep the photographer awake with freshly brewed coffee. But we were missing a major point, as our senior war editor Stewart Sidewinder reminds us: "Anything with a Hunter in it looks good." Which reminds me, anybody fancy jumping into the personal jet market with something elegant, fast, smooth. Something like, er.....a Hunter?



Just how high can you get?

For those nephews who recall the recent sad picture of forlorn ex-Royal Navy Phantom scrapyards gate guardian XT863, here is a nostalgic postscript. This picture, never to be repeated, was taken from XT863 during happier days when it took part in a Royal Tournament fly-by in July 1977. Thanks to Nephew (formerly Fg Off) Dick "Lotty" Lotinga who was at her controls at the time of the happy snap.

FLIGHT

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R.A.F. Sabres

The Air Ministry announces that, under arrangements which have been made between the authorities of the United Kingdom, Canada and the United States, the Royal Air Force is to receive between 300 and 400 F-86E Sabre fighters. Power plants, electronic equipment and instruments are being furnished by the United States through Mutual Defence Assistance Programme funds. The airframes are being supplied by, and built in, Canada, and the Sabres will be assembled there under Mutual

50
YEARS
AGO

Aid arrangements. Additionally, Canada is providing as Mutual Aid some power plants, armament and electronic equipment, as well as undertaking familiarisation training for the R.A.F. ferry crews.

The main delivery of the Sabres to the R.A.F., it is announced, will begin in December and should be completed during 1953. Under the agreed arrangement the fighters will be employed in the 2nd Allied Tactical Air Force under the command of Air Marshal Sir Robert Foster.

700 m.p.h. Saab

Designated Saab-32 (Swedish Air Force appellation A-32), Sweden's newest military aircraft is a two-seater intended for attack missions against ground and sea targets. Responsible for the flight tests now under way is Saab's chief test pilot, B.R. Olow.

The Saab-32 is considerably larger than the now-familiar Saab-29 (J-29) fighter and is claimed by the makers to have a top speed in the region of 700 m.p.h. The power plant is a Rolls-Royce Avon, aspirated through flush intakes. The mainplane is more sharply swept than that of the Saab-29 and is fitted with large Fowler-type flaps and leading edge slots – the latter to improve stability and manoeuvrability at the stall. Ailerons and elevator have hydraulic boosts; the nose wheel folds forward and the main wheels retract inwards into the fuselage. Under the fuselage nose is a triangular fin, which constitutes one of the aircraft's many antennae; others are completely submerged. Armament includes cannon, bombs and rocket projectiles, and there is comprehensive electronic equipment for navigation and combat in all kinds of weather and at night.

The one that got away

At Gatow Airfield, Berlin, R.A.F. lorry drivers tried to prevent the pilot of a Russian Mig-15 fighter from taking off after it had landed, apparently by mistake. A newspaper report says, a little oddly, that the authorities "are seeking ways of preventing similar 'invasions.'"

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The opinions on this page do not necessarily represent those of the editor. *Flight International* cannot publish letters without name. Letters must be no more than 250 words in length.

REGULATIONS**One rule for all in Europe?**

The term JAA stands for Joint Aviation Authorities, an associated body of the European Civil Aviation Conference representing the civil aviation regulatory authorities of a number of European states that have agreed to co-operate in developing and implementing common safety regulatory standards and procedures. This co-operation is intended to provide high and consistent standards of safety and a "level playing-field" for competition in Europe.

All the major European countries supposedly operate to the same JAA standard, but as all pilots are aware, this is certainly not the case. The main culprit is France, which refuses to allow pilots aged 60 to operate in its airspace when acting as pilot in command for commercial purposes. Should that pilot be operating an Airbus or Boeing privately, there are no restrictions, as long as that pilot holds a valid class one medical and is current with his flight checks.

The value of the JAA is beyond my comprehension when each individual country can vary the way the rules work to suit. Italy, for example, can substitute an extra inertial navigation system for an additional crew member to lengthen extended-range twin operations flights. It's certainly more cost effective than having another pilot, but is it safer?

As to the ability of older pilots to learn new skills, why is it that all the top surgeons, with few exceptions, are allowed to operate up to the age of 70. They are constantly learning new and difficult skills, and I know who I would sooner have operating on me.

Clapt Peter Shaw
UK

No force or discrimination

Mr Lucas (*Flight International*, 22-28 October) does no justice to the situation in the Netherlands. By collective agreement, the retirement age for pilots is 56, as he says, but it has nothing to do with discrimination or force. The retirement age was set for a number of reasons, greed not being one of them. Mr Lucas also committed himself to this agreement by signing his contract. Nobody forced him to do so. The retirement age of 56 was upheld in several court cases.

Retirements are one of the most prominent opportunities for low-seniority pilots to make promotion. To stretch the retirement age would mean fewer opportunities for them. Pilots in the regional group are in the same situation since the step to the major airlines has been formalised. Mr Lucas himself has received promotions based on this so-called discriminatory system. The question is why Mr Lucas would want to fly past the set age. It can't be a financial issue, since the retirement plans in the Netherlands are good. If Mr Lucas wants to extend his professional career he is free to do so, but under another collective agreement.

Evert van Zwol
Vice-president, VNV Dutch ALPA
Badhoevedorp, The Netherlands

Too many US hubs?

In his quest to ascertain the "more fundamental question" concerning United Airlines' restructuring, Mr Thomas (*Flight International*, 8-14 October) completely misses the reality of the US airline industry: too many hubs.

The fact that Southwest Airlines' market capitalisation exceeds the sum of the top half-a-dozen US hub airlines (as does Ryanair's in Europe) is the key to understanding where the solution lies.

The band-aid approach thus far applied by the US airlines cutting capacity by about 15% does nothing but aggravate their business models because the hub concept precisely depends on maximising connections.

In other words, the travails of the hub airlines do not imply that the hub model is invalid, but rather that overcapacity of hubs is the problem.

If the current 25 domestic US hubs were trimmed to a dozen or so, undoubtedly the financial results would be of another order of magnitude.

The reality, of course, is that this solution will not happen until the Chapter 11 bankruptcy protection options have been exhausted and the Trojan Horse of new domestic codesharing plays itself out, with

duplicate hubs being eliminated eventually.

In the meantime, the blood-letting will continue.

Arthur Smith-Vaughan
Nicaragua

Giveaway aircraft

Now EasyJet orders up to 240 Airbuses at great discount (*Flight International*, 22-28 October). What signal will it give to other airlines who have paid much more? They must feel they are idiots.

Airbus says it earns money on the deal, Boeing says it loses. Maybe next time airlines are out shopping for aircraft they'll ask for them free of charge. Maybe they'll ask to be paid to take them.

What will be next in the Airbus-Boeing sales circus?

Trond Eie
Tananger, Norway

Pie in the sky

I'm sorry, Paul Nunes (*Flight International*, 22-28 October), but the blended wing body airliner is a busted flush, at least until much better materials arrive and electronically constrained instability is proven to be safe for passenger transport.

Noel Falconer
Couiza, France

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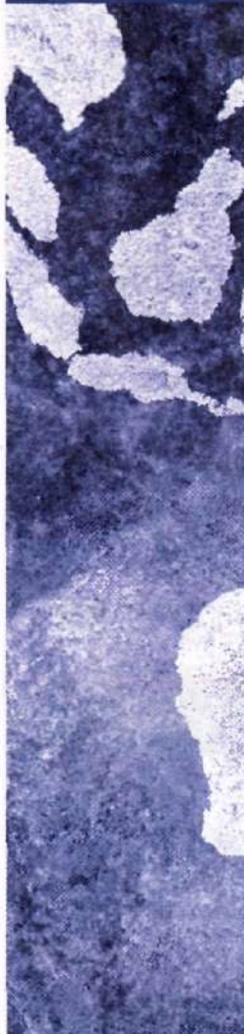
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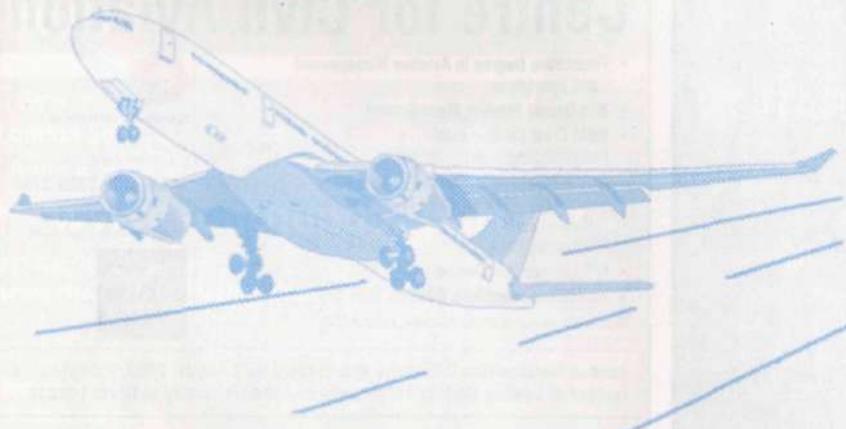
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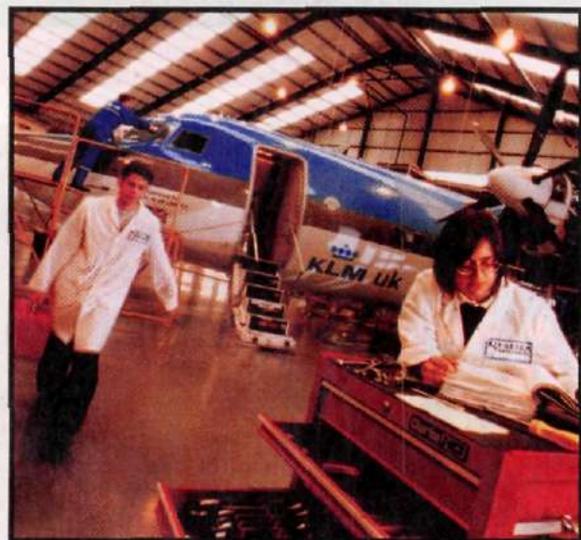
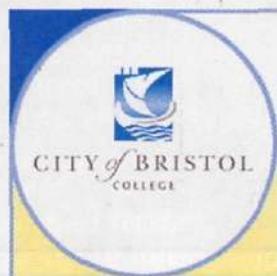
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Notes:

1. The consortia consists of Kingston University London, the only UK Government top rated Aerospace degree provider, together with the City of Bristol College and KLM UK Engineering, both JAR-147 approved Training Organisations.
2. Details of the JAR-66 and degree examination arrangements and experience requirements will be provided at the introductory enrolment meetings.
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For technical details please contact:

Professor Andrew Self FIEE, FRAeS, MinstMC, Sqn Ldr RAF Rtd.
Pro Vice-Chancellor and Head of the School of Engineering,
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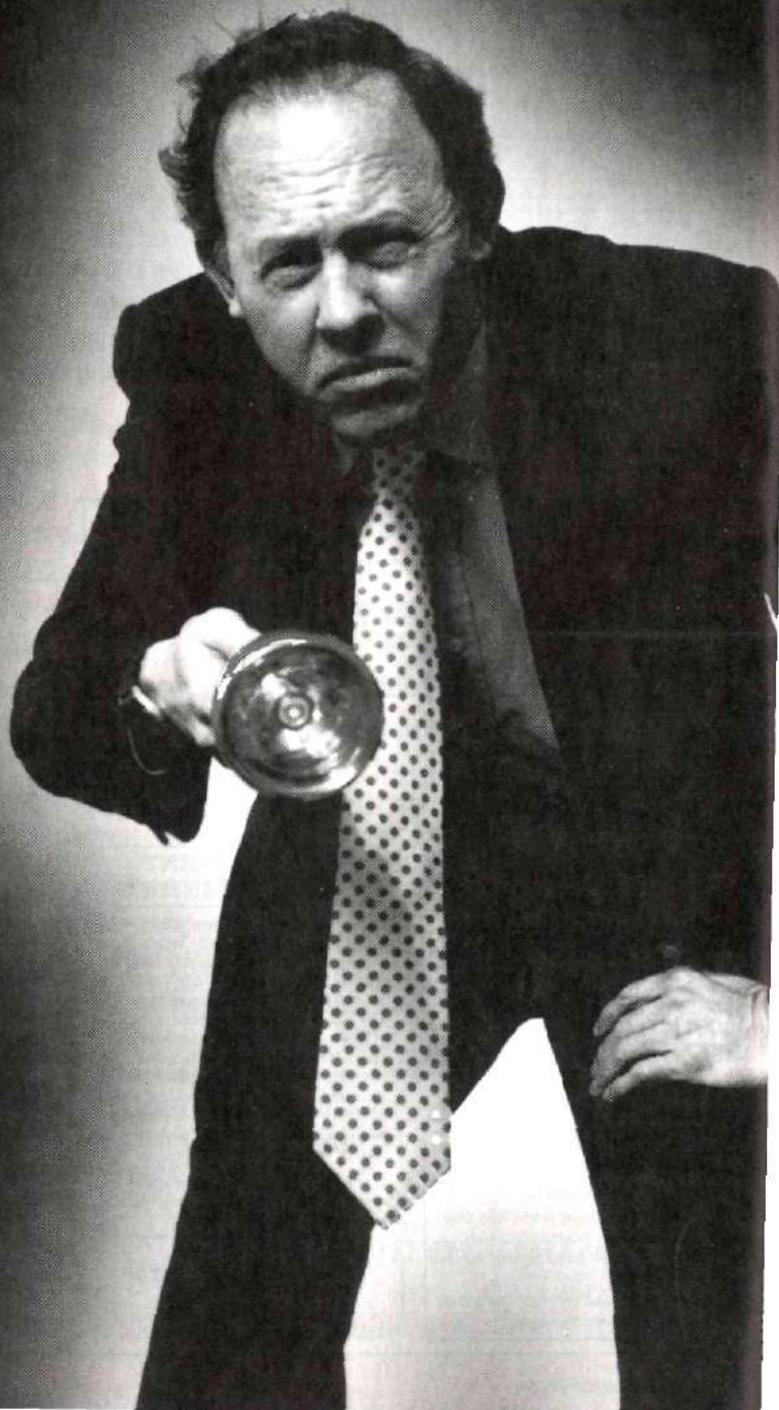
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