FLIGHT INTERNATIONAL

8-14 October 2019 | flightglobal.com

PROPULSION

Powering change

Our review of engine developments



£3.90

9 770015 371310 41

FARA-sighted
Bell unveils its vision for high-speed US Army rotorcraft **11**

Price TAG
Swiss owners sell Farnborough airport to Macquarie unit **23**

110 YEARS
1909-2019



Elevated expectations

For more than four decades, we've been a world leader in the design and development of flight controls, engine controls, and flight deck and cabin systems. Now we're using our expertise to produce world-class avionics for the next generation of aircraft that will feature autonomy, all-electric, and hybrid technologies.

baesystems.com/commercialsupport

BAE SYSTEMS

FlightGlobal

CONTENTS

Volume 196 Number 5706
8-14 OCTOBER 2019



US Navy EA-18G Growlers meet mission capability requirement **P18**

US Air Force

BEHIND THE HEADLINES

Greg Waldron took a trip to **Okinawa**, witnessing **US Marine Corps** attack helicopter operations (P21). He also compiled our preview package for Seoul's **ADEX** show (P32)



Daher

NEXT WEEK NBAA

We prepare for the business aviation community's Las Vegas gathering by flying Daher's speedy TBM 940

REGULARS

7 **Comment**
39 **Straight & Level**
40 **Letters**
42 **Classified**
44 **Jobs**
47 **Working Week**

NEWS

THIS WEEK

8 Boeing vows it will stick to 777-8 plan
9 WTO decision could trigger trade war
10 EasyJet 'on course' to hit 20% female recruitment target
11 Bell pitches Invictus as FARA conqueror

AIR TRANSPORT

12 Engine failures trigger inspection order. Max values unclear as grounding rules continue
13 O'Leary 'confident' Max will resume flights by early 2020. Components for customer C919s in production
14 Shorts 330 crash flags non-compliance
16 LHT pushes collaboration as component of future success. Partners launch first of-its-kind Vietnam facility

DEFENCE

18 US Navy hits mission capability target. NAVAIR order supports APKWS II output boost
19 China celebrates with show of strength
20 KF-X takes shape following key review

NEWS FOCUS

21 Marine stalwarts kept ready for action

BUSINESS AVIATION

22 SyberJet readies SJ30i for first flight. Cessna Longitude and Caravan hit milestones
23 Farnborough air show home sold to MIRA. US, European regulators validate Praetor 500

COVER STORY

25 **Rising pressure**

Powerplant makers face conflicting demands for performance, reliability and huge production rates – as revealed in our semi-annual survey of the commercial aircraft engine market



AirTeamImages

FEATURES

32 **Made in Korea**
While KAI's aspiration to develop a home-grown advanced combat jet is progressing, the complexities of its AESA radar programme – involving different contractors for hardware and software – and Indonesia's request to renegotiate the terms of its contribution remain significant challenges

34 **Top-end trainers get set for action**
Not all nations require, or can afford, latest-generation combat aircraft. This opens the door for several light attack jets on the market, including South Korea's own KAI FA-50, Leonardo's M-346FA and the Aero Vodochody L-39NG

36 **Surion back in business**
With the fault behind last year's fatal accident involving the Marine variant traced to defects in the main rotor mast, KAI is now targeting export and parapublic markets for its Surion utility twin, but safety concerns are still an issue

Download the 2019 Commercial Engines Report
now with updated enhanced data and in-depth market analysis
flightglobal.com/commengines
cfm
The Power of Flight

Image of the week

Brisbane's annual Sunsuper Riverfire event involved a spectacular flypast made by a Royal Australian Air Force Boeing C-17. The strategic transport performed a low-level, banking pass alongside skyscrapers on 28 September. Eight of the type are used by Amberley, Queensland-based 36 Sqn

View more great aviation shots online and in our weekly tablet edition:

flightglobal.com/flight-international



Adrian Wedderburn/Bav Media/Shutterstock

The week in numbers

9%

Cirium Dashboard

Ryanair says $20bn-worth of new 737-8s will help it cut carbon dioxide pollution per passenger km from 66g to 60g by 2030

£5.5m

Cirium Dashboard

Year to end-September 2018 losses at Thomas Cook Aircraft Engineering: like the rest of the group, it faces liquidation

70

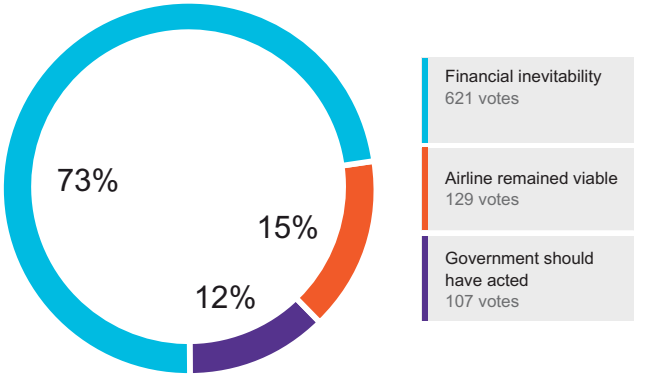
Qantas

Number of business-class seats on Qantas A380s following cabin upgrades; first modified jet re-entered service on 2 October

Question of the week

Last week, we asked: **Thomas Cook's demise?**
You said:

Total votes: 857



This week, we ask: **WTO dispute?**
❑ Airbus in the wrong ❑ Boeing guilty ❑ Both at fault

Vote at flightglobal.com

Cirium's premium news and data service delivers breaking air transport stories with profiles, schedules, and fleet, financial and traffic information **flightglobal.com/dashboard**



CIVIL SIMULATOR CENSUS NOW AVAILABLE ONLINE
www.flightglobal.com/civilsim
CAE

GO BEYOND



PRATT & WHITNEY
GTF

THERE IS NO COMPARISON. NO EQUAL. THERE IS ONLY ONE.

THE COMMERCIAL JET ENGINE IN A LEAGUE OF ITS OWN.

Powered by an industry-first geared architecture — and more than 40 other groundbreaking innovations — the **Pratt & Whitney GTF**™ is unlike any engine that's come before it.

EXPLORE THE FUTURE OF FLIGHT AT **PW.UTC.COM**

A UNITED TECHNOLOGIES COMPANY

FlightGlobal



Airline Digital Transformation Barcelona

3-4 December 2019
Barceló Sants Hotel

Becoming a more agile, customer-centric and insights-driven airline

This conference brings together leading digital, technology and commercial experts from the world of aviation, to explore the value new technologies and agile working practices hold for their organisation, and how best to ensure investments are prioritised to deliver maximum return.

Airlines will learn from experts on how to become more agile and responsive to the fast-pace of change in the industry, and are not left behind as new technologies and capabilities enable companies to secure a competitive edge.

Speakers confirmed:



Peter Abraham
Author: Building the Agile Business through Digital Transformation



Mohammed Ahteshamuddin
Vice President – IT (PSS & Customer Experience), **Flydubai**



Pam Aylward
Head of Customer Recovery
SkyTeam



Mohamed Shakir
Digital Innovation Researcher & TED Speaker, **Qatar Airways**



Eduardo Teixeira
Tactical Forecast Manager
Heathrow Airport

Find out more: flightglobal.com/transformation



Granger/Shutterstock

Cowboy tactics

All to lose

While Boeing may view World Trade Organization findings against Europe and Airbus as a victory, likely retaliation will ensure there are no real winners

When the Cold War descended into its sub-zero depths of paranoia, the prevailing assumption was that neither side would dare to initiate a thermonuclear exchange because, no matter how intense the first salvo, the retaliatory strike would be sufficient to obliterate the aggressor.

This military doctrine was known as mutually assured destruction and, while the concept preceded creation of the hydrogen bomb, the cataclysmic power aimed by each side at the other meant the aptness of its acronym, MAD, applied like never before.

While the principle seemed sound, it suffered from a critical flaw. It relied on the rational recognition that any attempt to succeed was certain to result in failure. But political leaders are not always rational. Some are tempted to believe that they can win the unwinnable war.

After 15 years of being confined to World Trade Organization offices in Geneva, the transatlantic civil aircraft subsidies dispute between Boeing and Airbus suddenly stopped being a cold conflict earlier this year when the US Trade Representative launched a pre-emptive attack on the EU's industry.

Prior to that, the stand-off had become a tedious side-show, occasionally throwing up turgid legal rulings running to hundreds, even thousands, of pages after which Boeing and Airbus would cherry-pick or spin the findings to align them with its own narrative – that the opposing government was unfairly funding their competitor, the cheats. Nothings was solved and only lawyers got rich.

No-one seems surprised this particular cold war has gone 'hot' on President Trump's watch, after his tariff-driven belligerence against China. "Nixon played the madman," a source close to the dispute recently told *Flight International*. "Trump is the madman."

The transatlantic civil aircraft subsidies dispute between Boeing and Airbus suddenly stopped being a cold conflict

Although the challenge will be one of the first facing incoming European Commission president Ursula von der Leyen, a European counterstrike intended to inflict equal, or greater, damage is planned.

Airbus believes a negotiated settlement is the sensible way through. It appears to be offering a truce to an antagonist that fired the first shot and one that still believes, despite the threat of retaliation, it can claim victory.

Such a perceived triumph might have unexpected long-term consequences if Airbus ultimately feels competitively disadvantaged. This potential aspect of the scrap is, so far, unexplored. But destruction can still be mutually assured, even if it takes more time to deliver by manoeuvring than by missile. ■

See This Week P9

Join the party

Beijing's vast parade on 1 October, celebrating 70 years of Communist Party rule, again underlined – as if there was any doubt – its dream of military domination in the Asia-Pacific.

The intercontinental ballistic missiles (ICBMs), cruise missiles, hypersonic glide vehicles, unmanned combat air vehicles (UCAVs), and swarms of combat aircraft and helicopters jarred somewhat with President Xi Jinping's remarks about peaceful development – not to mention the continued riots in Hong Kong.

But ignore Xi's platitudes and the message is clear: China means to dominate its near seas through airpower and a massive array of precision missiles. All this is backed by an increasingly powerful, and mobile, nuclear deterrent centred on the new DF-41 ICBM.

Though the parade was largely for domestic consumption, weapons designations were clearly labeled for Western viewers: DF-41, DF-26, GJ-11, JL-2, and the DF-17 hypersonic glide vehicle.

Similar to how defence experts of yesteryear were certain that every Soviet capability ever to appear in public was a devastating one, today's legion of online pundits rushed to assume that everything Beijing showed off both works and has been deployed.

While the GJ-11 Sharp Sword UCAV first flew in 2015, the example carted on a parade float lacked key details and looked like a mock-up. One up-close observer said the special forces gyrocopters in the parade looked "amateurish". Were there really missiles in all those containers? Has China really cracked the secrets of hypersonic flight?

Despite the considerable questions, it is impossible not to take all this kit seriously, and the expansionist intent behind it. Welcome back, Cold War.

See Defence P19


Xinhua/Shutterstock

Diplomacy by other means

BRIEFING

P&W POWERS TO F135 PRODUCTION DEAL

ENGINES The US Department of Defense has awarded Pratt & Whitney a $5.7 billion contract covering the 12th and 13th low-rate initial production lots of F135 engines for the Lockheed Martin F-35. P&W says the deal – which also includes priced options for lot 14 – funds at least 332 engines for the US military and international customers.

FIRST SILKAIR MAX ARRIVES IN ALICE SPRINGS

STORAGE On 30 September, the first of six SilkAir Boeing 737 Max 8s arrived in Alice Springs, Australia, where it will be placed in storage, pending the type's eventual return to service. SilkAir's Max fleet has been in storage at Changi airport in Singapore since March, when the type was grounded.

H225S PITCHED FOR GREENLAND SAR

ROTORCRAFT Air Greenland will acquire two Airbus Helicopters H225s to support its bid for the nation's search and rescue (SAR) contract. The airframer says it will "over the coming months" supply medium-twins repurposed from use in the oil and gas sector. Air Greenland chief executive Jacob Nitter Sorensen describes the aircraft as having "low numbers of flight hours" and offering "remarkable capability on SAR operations".

EU PROBE DELAYS BOEING-EMBRAER TIE-UP

REGULATION Boeing and Embraer have delayed the expected close of their commercial aircraft joint venture until early 2020 due to a regulatory hold-up. The European Commission has launched a Phase II study into the planned tie-up, which would see Boeing acquire 80% of Embraer's commercial aircraft division for $4.2 billion. This will push back the closing from end-2019.

THAI FORCED TO REJIG ACQUISITION PLAN

FLEET Thai Airways International has six months to submit a revised aircraft acquisition plan following a decision by the carrier's board related to funding sources. These must be "most appropriate for the current situation", it says. Thai was reported to be looking for 38 aircraft – both single- and twin-aisles – worth a total of Bt156 billion ($5.1 billion).

MANILA TAKES CONTROL WITH G280

ORDER The Philippine air force has ordered a single Gulfstream G280 business jet for command and control missions. Delivery is expected in 2020. No contract value has been revealed. Media reports from the Philippines suggest one mission for the super-midsize aircraft will transporting president Rodrigo Duterte.

TESTS HINT AT END FOR BRANDENBURG WAIT

AIRPORT Berlin Brandenburg airport's operator, FBB, believes the October 2020 opening date for the much-delayed capital hub is still realistic, following operational principle tests of Terminal 1. Work involved an assessment of system-wide functioning of the airport and its safety mechanisms, including fire-protection equipment. FBB held a supervisory board meeting on 27 September to discuss the results of the activity which, it says, have been "positive".



Boeing

Engine problems have raised doubts over both aircraft's schedule

PROGRAMME **MAX KINGSLEY-JONES** BERLIN

Boeing vows it will stick to 777-8 plan

Airframer quashes speculation model would be cancelled, saying ultra-long-range jet is 'absolutely part of the family'

A Boeing official says the airframer remains fully committed to developing the ultra-long-range 777-8, despite a decision to shelve its development while focusing on recovering the schedule for the baseline 777-9 variant.

The manufacturer confirmed in August that it would "adjust" the -8's schedule, to "[reduce] risk in our development programme, ensuring a more seamless transition". This fuelled speculation that it could terminate development of the variant, which has so far only found niche appeal. Boeing's 344-strong order backlog for the 777X includes only 53 in the -8 standard.

However, when challenged by Airbus during a panel discussion at the ISTAT EMEA conference in Berlin in late September about the uncertainty hanging over the 777-8, Darren Hulst, Boeing senior manager for market analysis and sales support, robustly restated its commitment to the aircraft.

"The 777-8 is absolutely part of the [777X] family, and the key is we want to make the absolute right aircraft for the customers that need it," he says.

Deliveries of the -8 had been due to begin a year after the -9, which would have originally meant mid-2021. However, the ongoing slippage in the -9 programme due to technical issues with its GE Aviation GE9X engines means that the entire 777X schedule is currently unclear.

Boeing will phase out its current 777 passenger models next year as it switches to the new versions, although production of the -200LR-derived 777F freighter will continue in the short term.

The company secured two additional 777-300ER orders last month from KLM and currently has 34 left on firm backlog to deliver, plus two -200LRs. It sold 45 777Fs in 2018, and has added a further 15 so far this year, aiding its production bridge to the new commercial models, which also differ by using a carbonfibre wing.

"With the strong demand for the 777F, we have inserted additional positions into the 'skyline' in lieu of 777X positions," Boeing tells FlightGlobal.

Ultimately, the company intends to develop a freighter version in the 777X family from the 777-8. But regardless of such plans, Hulst is adamant that "we'll see a -8 as a passenger airplane, absolutely". ■

See Feature P25



Bell pitches Invictus as FARA conqueror
This Week P11

DISPUTE **ALFRED CHUA** SINGAPORE **DAVID KAMINSKI-MORROW** LONDON & **JON HEMMERDINGER** BOSTON

WTO decision could trigger trade war

European Commission warns USA against implementing 10% import tariff on civil aircraft and threatens retaliation

A long-standing legal wrangle between the EU and USA over subsidies for civil aircraft manufacturers is threatening to escalate into a fully fledged trade war after a landmark World Trade Organization (WTO) decision.

Following the 2 October WTO ruling, which permits the USA to impose $7.5 billion-worth of annual tariffs on European products, Washington DC said that its new levies could kick in from 18 October.

The row centres on EU subsidies for Airbus, which the WTO arbitrator heavily criticised as being "WTO-inconsistent", and had caused adverse effects to the USA.

While the US Trade Representative (USTR) is allowed to impose up to 100% tariffs on $7.5 billion of goods, the office says it will initially impose 10% levies on new commercial aircraft of more than 30 tonnes – and 25% duties on other products such as Irish and Scotch whiskies, German machinery, and Italian cheese.

However, the USA has the authority to increase the tariffs at any time, or change the products covered, the USTR notes.

EXEMPTIONS

Crucially for Airbus, the USTR list does not mention structures such as wings or fuselage sections, allowing the manufacturer to continue shipping these to its A320-family assembly line in Mobile, Alabama. Aircraft built there, or A220s built in Canada, will not be subject to the new levy.

But with A320 output at Mobile currently at four aircraft per month, Airbus will also need narrowbodies built in Hamburg and Toulouse to fulfil the requirements of US customers.

According to Airbus data for the period to 31 August, the airframer had outstanding orders for 584 narrowbodies from US carriers, plus 32 A330neos and 57 A350-900s.



Virginia Mayo/AP/Shutterstock

EU's Cecilia Malstrom argues measures would damage businesses

Delta Air Lines is potentially the most exposed to any tariff-driven price rise, with 181 aircraft possibly subject to the 10% levy: 37 A321ceos, 100 A321neos, 32 A330neos and 12 A350s.

In addition, two customers – Delta and United Airlines – have outstanding orders for European-built widebodies.

> "After 15 years of litigation, the WTO has confirmed that the United States is entitled to impose countermeasures"
>
> **Robert Lighthizer**
> Trade representative, USA

In the aftermath of the latest ruling, US trade representative Robert Lighthizer says: "For years, Europe has been providing massive subsidies to Airbus that have seriously injured the US aerospace industry and our workers.

"Finally, after 15 years of litigation, the WTO has confirmed that the United States is entitled to impose countermeasures in response to the EU's illegal subsidies."

The WTO is set to rule on Boeing's subsidies early next year, which could pave the way for the EU to hit back at the US airframer with retaliatory tariffs, a counter-strike that European trade regulators are promising within months.

TARGET LIST

The European Commission has already drawn up a list of US export targets collectively worth about $20 billion.

No WTO decision has been made on the size of the counter-award but European trade commissioner Cecilia Malmstrom says the EU will "in some months, equally be granted rights" to impose tariffs against US exports, including commercial aircraft.

She urges the US administration to resist implementing its tariff award, adding: "Opting for applying countermeasures now would be short-sighted and counterproductive."

Such a decision would inflict damage on businesses, including the aviation industry, at a "sensitive time", she says.

Malmstrom discloses that the EU has put forward "concrete proposals" for a "new regime" on aircraft subsidies, but claims the US side has, so far, "not reacted".

Airbus says the EU countermeasures claim "could exceed" those granted to the US administration, ultimately forcing customers on both sides to pay higher costs for aircraft.

It has reiterated its position that a negotiated settlement is the most reasonable strategy to resolving the dispute, which Boeing sparked exactly 15 years ago this week – under the administration of then-US president George W Bush – by withdrawing from the 1992 transatlantic agreement on civil aircraft subsidies and launching a WTO case. This prompted the EU to respond with a parallel WTO challenge.

Boeing's complaint has centred on repayable launch aid from EU member states, which Airbus insists is not a subsidy in the same fashion as grants or tax breaks.

Airbus has alleged, in turn, that Boeing benefited from support through various federal, state and local authorities – particularly within the states of Washington and South Carolina, and the city of Wichita – as well as the US Foreign Sales Corporation scheme. It has also claimed that the US Department of Defense and space agency NASA have provided several billion dollars' worth of subsidies to Boeing.

The WTO arbitrator's 2 October report came down hard on Airbus. "Effective countermeasures are the last remaining hope to force the EU to reckon with the pernicious effects its [launch aid and member state financing] subsidies cause, and hopefully achieve a solution to this long-standing failure to comply with its WTO obligations," says the report.

The EU provided "WTO-inconsistent" launch aid and funding to "every single" Airbus large commercial aircraft programme and caused "massive adverse effects to the United States", it adds. ■

FLIGHTCREW **DOMINIC PERRY** LONDON GATWICK

EasyJet 'on course' to hit 20% female recruitment target

Budget carrier's goal to increase intake of women training for cockpit career will be met by 2020, says provider CAE

UK budget carrier EasyJet is on course to meet its target to ensure that 20% of its new pilot intake is female by 2020.

Marc Parent, chief executive of simulator specialist CAE, says EasyJet "will achieve this goal next year".

Parent, speaking on 1 October at the opening of a new training centre at London Gatwick airport for which EasyJet is the largest client, said the fact that only 5% of pilots globally are women is a "truly shocking statistic".

David Morgan, interim chief operations officer at EasyJet, declines to confirm Parent's comment, but says the carrier achieved a female intake rate of 15% in 2018 and is "on target" to reach the higher figure next year.

A more ambitious goal is likely to follow in the future, and a "new plan will be shared towards the end of the year", says Morgan.

Inauguration of the Gatwick facility, which includes five Airbus A320 simulators dedicated to EasyJet, came days after the opening of a second site in Manchester, with a third facility in Milan to come on line on 10 October.

Supported by a 10-year agreement struck in November 2018 between the training provider and the carrier, the deal represents an investment by EasyJet of £100 million ($123 million) over the period.

There are currently seven full flight simulators installed at Gatwick: five for the A320 and single units for the A330 and A350. A new Boeing 787 device will be added shortly, while five more simulators will be moved from CAE's existing Gatwick site by the end of next year. A CAE 600XR flight training device will also be added before year-end.

Other carriers using the Gatwick facility – CAE's largest site in Europe – include Aurigny, LOT Polish Airlines, Norwegian, SAS, TUI and Virgin Atlantic.

At full capacity, the site will be capable of training 13,000 pilots each year, as well as providing instruction for cabin crew. ■



Aircraft was hit by lightning and made a hard landing at Moscow

Maxim Shipenkov/EPA-EFE/Shutterstock

INQUIRY **DAVID KAMINSKI-MORROW** LONDON

Pilot of Aeroflot Superjet charged over fatal crash

Criminal investigators have charged the captain of an Aeroflot Sukhoi Superjet 100 in connection with the fatal landing accident at Moscow Sheremetyevo airport earlier this year.

The Murmansk-bound aircraft returned to Sheremetyevo after a lightning strike but bounced heavily during the landing, igniting spilled fuel when the landing-gear collapsed.

Forty-one of the 78 occupants died in the accident.

The captain had taken manual control of the Superjet after the lightning strike, and the investigation has highlighted heavy-handed and abrupt inputs to the side-stick during the approach and touchdown.

Russia's Federal Investigative Committee says that the aircraft made a rough landing, adding that the captain's actions to control the jet were "in violation of established rules" and led to the airframe damage and the outbreak of fire.

It states he is being charged with a crime relating to breaches of air transport safety rules which, as a result of negligence, resulted in two or more fatalities.

The committee says 10 people on board received injuries of varying severity, adding that the criminal investigation is continuing. ■



Airbus

DELIVERY

'Toulouse' is a winner for Air France

Air France has taken delivery of its initial Airbus A350-900 – named Toulouse in honour of the city in which it was built – the first of 28 the SkyTeam carrier has on order. The French carrier will receive all 28 of its parent group's on-order A350s after agreeing a recent swap under which it will take seven originally destined for sister carrier KLM. Air France-KLM group chief executive Ben Smith says: "This [aircraft] forms a foundation for our future standardised and more streamlined fleet." The airline will take delivery of its first three of the Rolls-Royce Trent XWB-powered type this year, with a further three to join the fleet by next summer. Eleven more will follow by the end of 2021 and all 28 will be delivered by the end of 2025. The aircraft are equipped with 34 seats in business class, 24 in premium economy and 266 in economy.



Engine failures trigger inspection order
Air Transport P12

REQUIREMENT **GARRETT REIM** LOS ANGELES

Bell pitches Invictus as FARA conqueror

Airframer presents conventional single-engined helicopter concept for US Army's next-generation armed scout need

Bell has unveiled initial renderings of the newly-named 360 Invictus helicopter, which it is proposing for the US Army's Future Armed Reconnaissance Aircraft (FARA) competition.

Currently in the preliminary design phase, the 360 Invictus is scheduled to fly by the autumn of 2022 if the US Army gives Bell a green light and funding to build the first prototype.

Bell is competing against four other companies for the FARA contract: AVX Aircraft, Boeing, Karem Aircraft and Sikorsky.

The US Army is working to a rapid timeline, with a plan to develop, flight test and field its next-generation reconnaissance aircraft by 2028. It anticipates awarding two teams contracts in 2020 to build prototypes, with a fly-off competition in 2023. FARA would be a replacement for the service's retired fleet of Bell OH-58D Kiowa Warriors.

Bell's design borrows the rotor system of the 525 Relentless, a super-medium-lift commercial helicopter designed to transport up to 19 passengers and aimed at the oil and gas industry.

The twin-engined 525, which has a fully-articulated rotor with five composite blades, is presently still undergoing Federal Aviation Administration (FAA) certification testing.

However, the four-blade main rotor on the 360 Invictus would be significantly smaller than that on the 525. That is partly driven by the US Army's requirement for an aircraft with a maximum rotor diameter of 12.2m (40ft) – a specification meant to allow the FARA to manoeuvre between buildings in urban battlefields.

Bell says the 525's rotor system has been tested at speeds above 200kt (371km/h), though it advertises the Invictus's speed as over 185kt. The US Army wants the FARA to have a cruise speed of at least 180kt.

UPGRADE PATH

"Certainly with our configuration there's opportunities to continue to mature or block upgrade the aircraft [speed], if they want more capability," says Frank Lazzara, director of advanced vertical lift systems sales and strategy at Bell. "But we're trying to ensure that the focus stays on the affordability and sustainability."

Additional capability is provided by short wings, which contribute up to 50% of lift in forward flight.

Designed with a combat radius of 135nm (250km) and more than 90min of time on station, the aircraft should be able to hover out of ground effect at 4,000ft at 35°C (95°F), says Bell.



Bell

High-speed design involves internal weapons pod and a ducted tail

To reach high speeds, Bell has streamlined the 360 Invictus's profile with internal weapons carriage, main rotor shroud, retractable landing gear and a ducted tail rotor, which is also canted, providing additional lift in the hover.

The helicopter also has a patent pending "supplemental power unit," which the company declines to discuss in detail.

In addition, the Invictus would also have a horizontal stabilizer that is controlled by a fly-by-wire flight-control system to reduce drag in forward flight.

Bell says the reliance on the 525's rotor system is a low-risk route for the US Army, with high technology and manufacturing readiness levels. However, the commercial 525, which was due to enter service several years ago, has been delayed several times.

Bell is also critical of more complex designs, which it says come with inherent cost – a thinly veiled swipe at leading competitor Sikorsky, whose S-97 Raider co-axial compound helicopter is widely viewed as the favourite in the FARA competition. The Raider first flew in 2015 and has achieved speeds above 200kt in test flights.

But because the 360 Invictus is still in the preliminary design phase and not scheduled to fly before the latter part of 2022, it would start out at least six years behind the flight-test programme of the S-97 Raider. ■



PROPULSION **DAVID KAMINSKI-MORROW** LONDON

Engine failures trigger inspection order

Stage-one rotors on PW1500G low-pressure compressors broke as two London-bound A220s climbed to cruise altitude



Swiss

Powerplants with fewer than 300 cycles require repetitive borescope inspections under FAA directive

Operators of Airbus A220s are being instructed to conduct checks of the low-pressure compressor on Pratt & Whitney PW1500G engines, following two similar incidents involving failures on Swiss aircraft.

The incidents – on 25 July and 16 September – both occurred to Swiss A220-300s operating the Geneva-London Heathrow route.

Operators of the type have been told in a US Federal Aviation Administration (FAA) directive to perform initial and repetitive inspections of the compressor's inlet guide vane and the stage-one rotor.

Both Swiss A220 incidents involved failure of the stage-one rotor, resulting in the rotor being released from the low-pressure compressor case and damaging the engine.

"[Such] rotor failures historically have released high-energy debris that has resulted in damage to engines and [aircraft]," says the FAA directive.

It adds that, owing to similarity of design, it is extending the inspection regime to Embraer E2-family jets fitted with PW1900G powerplants.

The directive covers engines that have accumulated fewer than 300 cycles.

Initial inspections must take place within 50 cycles and within each subsequent interval of 50 cycles until the engine reaches this 300-cycle threshold.

They require borescope inspection of the rotor for damage or cracks at the blade tips, leading edge and other areas, as well as checks on the inlet guide vane stem for misalignment.

P&W issued a service bulletin on 23 September covering the borescope procedures. The FAA says the directive, which takes effect immediately, is an interim measure because the investigation into the Swiss A220 engine failures is still continuing.

The second of the failures came less than two months after the first incident.

The aircraft (HB-JCA) had been operating Geneva-London Heathrow on 16 September when the failure occurred in the left-hand PW1500G engine during climb.

US National Transportation Safety Board investigators state that the incident took place just before the twinjet reached its cruising altitude of 35,000ft.

The crew returned to Geneva after carrying out quick-reference handbook procedures and declaring an emergency. Inspection of the aircraft after it landed showed that the stage-one rotor in the low-pressure compressor had separated and there was a hole in the compressor case.

French investigators were already looking into the failure of the left-hand PW1500G on another Swiss A220-300, under similar circumstances, on 25 July. The aircraft (HB-JCM) had departed Geneva for Heathrow and had been climbing through 32,000ft when the failure occurred.

The stage-one rotor of the low-pressure compressor was found to be missing after the jet diverted to Paris. ■

MARKETS **MAX KINGSLEY-JONES** BERLIN

Max values unclear as grounding rules continue

Potential implications of the Boeing 737 Max grounding on future values of the aircraft topped the agenda for the appraiser panel at the ISTAT EMEA conference in Berlin on 25 September.

The consensus was that it would be premature to draw any conclusions about the potential long-term effects of the grounding, which has so far lasted six months.



Etienne Laurent/EPA-EFE/Shutterstock

Operators of latest 737 cannot easily substitute it, say appraisers

Olga Razzhivina, senior ISTAT appraiser with aviation consultancy Oriel, argues that, prior to the grounding, the value perception of the Max was already less rosy than that of its predecessor, the market-leading 737-800.

Razzhivina says the Max is "not exactly a mirror image" of the 737NG, and the changes Boeing had to make to integrate the CFM International Leap-1B engines, in her view, "compromised" the re-engined variant.

"And we did not have as strong a view of Max 8 [values] as a 737-800 to start with," says Razzhivina. "However, there is no other choice for Max operators so they will have to stick with it.

"The big question is whether the ensuing technical fixes and regulatory uncertainty have pushed Boeing far enough to curtail the Max and develop an all-new single-aisle, which obviously wouldn't help the value retention of the aircraft." ■



Shorts 330 crash flags non-compliance
Air Transport P14

FLEET **LEWIS HARPER** LONDON

O'Leary 'confident' Max will resume flights by early 2020

Suspension of deliveries will affect capacity growth for summer season, Ryanair chief says

Ryanair group chief executive Michael O'Leary is frustrated that the Boeing 737 Max grounding is slowing the operator's capacity growth, but is "reasonably confident" the aircraft will return to service in Europe by early 2020.

The situation "will slow our growth into summer 2020", O'Leary said at a Reuters Newsmakers forum on 1 October, adding that "when an opportunity comes up like the failure of Thomas Cook… we want to be able to grow faster, not slower".

He adds there could be further base cuts and job losses at the carrier if its expectation that the Max will be cleared to fly "either this side of Christmas or maybe the far side" is too optimistic.

Those cuts would come despite Ryanair's moves to delay the exit of some 737NGs from its fleet to partially offset the lack of Max deliveries.

He notes, however, that despite his frustration "safety is our main priority".

Reiterating earlier estimates that Ryanair would only be able to take about half of its Max backlog by the 2020 summer season, O'Leary says that at maximum capacity, the airline can receive eight new aircraft per month.



Tomasz Kowca/East News/Shutterstock

Carrier may have to cut jobs despite measures mitigating impact

"If it's back flying by January or February… we could take maybe 30 to 40 aircraft for next year, but we won't be able to take all 60," he says, referring to the backlog of Max deliveries the carrier would have accrued by the 2020 summer season.

"If it's slightly later, it could come down to 30. Most of our planning at the moment is based on 30 Max aircraft for next year."

Any further delay will mean "we have to look again at our summer 2020 capacity. That might involve more cuts and some more job losses," O'Leary says.

In early August, the Ryanair chief had already stated that "we will need about 600 less pilots and cabin crew for summer 2020" based on the assumption that the operator would receive around 30 Max jets during 2020.

Ryanair is taking steps to mitigate the impact of the Max grounding, O'Leary says, citing a deal reached with lessor GECAS under which Ryanair will keep seven of 10 "older 737NGs" that the operator had originally intended to sell this winter.

"We're also extending some of the aircraft that are coming off lease at the moment," he says.

Ryanair had been due to receive its first 737 Max 8 in April 2019. Cirium fleets data shows that Ryanair has 423 737NGs in service. The Irish carrier has 135 Max 8s on firm order and holds options on a further 75. ■

PROGRAMME
ALFRED CHUA SINGAPORE

Components for customer C919s into production

Comac has started component production for the first batch of C919 customer aircraft.

The Chinese airframer states that the narrowbody's wingbox, as well as other structures, are being built at factories in Chengdu, Shanghai and Xian.

Comac is partnering with AVIC subsidiaries Chengdu Aircraft Industry and Xian Aircraft for this stage of production.

Xian Aircraft is responsible for developing the C919 main fuselage and wingbox sections, which Comac says account for about 35% of the aircraft's total structure. Chengdu Aircraft Industry is handling development of the front fuselage and nose.

Comac will build the main fuselage and wings, as well as perform final assembly.

The airframer says the start of component production marks "substantial progress" for the CFM International Leap-1C-powered narrowbody programme.

Meanwhile, AVIC has joined the wings of the first MA700 twinturboprop, with the initial example to serve as a static test aircraft.

AVIC says 2019 is an "important year" for the programme and is targeting completion of assembly by year-end. To date, the Pratt & Whitney Canada PW150C-powered aircraft has attracted 285 orders from 11 operators. ■

DELIVERY

First 787-10 handed over to Saudia

Saudia has marked the delivery of its first Boeing 787-10 with a ceremony at its base at Jeddah's King Abdulaziz International airport. The new Dreamliner, which joins Saudia's existing fleet of 13 787-9s, will play a key role in the airline's fleet and network expansion, it says. Cirium fleets data shows only one 787-10 has been confirmed for Saudia so far. However, chief executive Jaan Albrecht told FlightGlobal earlier this year that the airline planned to introduce three examples in 2019 and a further seven in 2020. Saudia's 787-10s can accommodate 357 passengers in a two-class layout, comprising 24 business-class seats and 333 seats in economy.



Saudia

ACCIDENT **DAVID KAMINSKI-MORROW** LONDON

Shorts 330 crash flags non-compliance

Inquiry voices 'long-standing concern' over deliberate departures from landing procedure after May 2017 tragedy

US investigators probing a fatal landing accident involving a Shorts 330 freighter have determined that the crew had a history of intentional procedural non-compliance during approach, including late turns, high descent rates and excessive manoeuvring.

The twin-engined Air Cargo Carriers aircraft was 5° nose-down and banked 22° to the left when it struck runway 5 at about 92kt (170km/h) while attempting to land at Charleston, Virginia, on 5 May 2017.

It departed the left side of the runway, its left wing breaking away, and the aircraft tumbled into rough ground. Neither of the two crew members, the only occupants, survived.

National Transportation Safety Board (NTSB) investigators reviewed 17 of the crew's landings at the same airport – of which 10 were on runway 5 with the other seven on runway 23 – in the month before the accident.

Surveillance camera footage was only available for the seven landings on runway 23, all visual, but it showed that the approaches – from final turn to flare – lasted 12-39s, much shorter than the 75s for approaches flown in accordance with the operator's standard procedures.

Four of the seven approaches analysed had been flown by the captain, the others by the first officer. They had been permanently paired by the carrier.



NTSB

Neither crew member survived impact at Charleston, which caused left wing to separate from freighter

SERIOUS MISGIVINGS

Information released earlier by the inquiry indicated that the first officer had previously expressed concerns – in text messages to friends – about the captain's manner and flying abilities, including apparent discomfort and poor performance when flying in instrument conditions. She described one particular incident in a snowstorm, four months earlier, as "the biggest scare of my life".

These text messages and follow-up interviews, the NTSB says, suggest the first officer was "not in the habit of speaking up" and that the difference in experience – the captain had nearly 4,400h flight time compared with the first officer's 650h – probably created a steep authority gradient and a "barrier to communication".

> "The captain's recent performance history indicated that his instrument flight skills were marginal"
>
> National Transportation Safety Board

The crew, while 38nm (70km) west of Charleston, had been told to expect the localiser approach to runway 5 but instead requested the VOR-A circling approach, possibly because this matched the inbound flightpath while the localiser approach would have taken longer.

But the inquiry says the decision was "contrary" to the operator's procedures because the localiser approach was available.

FATAL DESCENT

Radar information showed the aircraft, while following the VOR-A approach, prematurely descended to 1,600ft – below minimum altitude – before reaching the waypoint FOGAG, lying 2nm from the missed-approach point. It remained at this altitude until 0.5nm from the runway threshold, then started a descent at 2,500ft/min.

It turned steeply to the left, crossing the centerline at a bank angle of 42°, with the descent rate reducing to about 600ft/min just before impact. There were "indications of increasing pitch", says the inquiry, suggesting the captain was pulling up as the aircraft neared the ground.

"However, it was too late to save the approach," it states.

Investigators were unable to conclude whether the captain descended below the minimum descent altitude before exiting cloud cover in the vicinity of the airport.

But the inquiry says the descent rate was not in accordance with company guidance, which required maintaining about 500ft/min, and the crew should have executed a go-around.

"No evidence was found to indicate why the captain chose to continue the approach," it states. "However, the captain's recent performance history, including an unsatisfactory check ride due to poor instrument flying, indicated that his instrument flight skills were marginal.

"It is possible that the captain felt more confident in his ability to perform an unstable approach to the runway compared to conducting the circling approach to land."

Intentional non-compliance with procedures is a "long-standing concern" of the NTSB, says the investigation authority, but Air Cargo Carriers had no formal safety and oversight programme to assess compliance with operating procedures or to monitor pilots with performance issues. ■

VIVISUN®

Advanced Lighted Pushbutton Switches and Indicators

There's Never Been a Better Time to Make the Switch



12 *Internal* **NEXSYS** *Component Options*

VIVISUN® has set the standard in ruggedized MIL-SPEC avionics switches and indicators for more than 50 years. With advanced internal NEXSYS® component options, our products simply outperform the competition.

If you're looking for personal customer service, worldwide factory support and the industry's fastest delivery, it's time that you make the switch to VIVISUN, manufactured by Applied Avionics.

Speaking of making the switch, our easy-to-use Part Configurator allows you to design a switch and get a complete part number 24/7 as part of our online paperless ordering process.

Ready to make the switch? Visit our website at:

www.AppliedAvionics.com/VIVISUN

Manufactured by
Applied Avionics

Fort Worth, Texas, USA
Sales and Support: +1 (888) 848-4786

©2019. VIVISUN® and NEXSYS® are registered trademarks of Applied Avionics, Inc. All rights reserved.

STRATEGY **ALFRED CHUA** SINGAPORE

LHT pushes collaboration as component of future success

Pact with Meggitt in China highlights German company's increasing interest in tie-ups

German MRO giant Lufthansa Technik (LHT) has underscored its appetite for industry partnerships, following a recent agreement to set up a component repair facility in China in conjunction with Meggitt.

Under the pact, the company will provide MRO services at Meggitt's Shenzhen facility. It is LHT's first partnership with an OEM in China.

Gerald Steinhoff, LHT senior vice-president for corporate sales in the Asia-Pacific, says there was collective enthusiasm for the project. "Meggitt had an interest to find the best repair option in China, and we were interested in going into a partnership with Meggitt, and having the option to repair these parts in Shenzhen," he says.

Burkhard Pfefferle-Tolkiehn, LHT vice-president component services in Asia-Pacific, adds: "What we can offer to Meggitt is that we have access to the China market… so we can be their exclusive partner for China."

He describes the agreement as a "win-win" for both parties through combining their separate competencies.

LHT is increasingly looking to collaborate with the wider industry, and Steinhoff says it makes sense to "bundle your resources".

"In case we find someone who is best for a certain product, we are very open to discussion, because we want to remain number one in the industry," he says.

"I think the tendency towards partnerships is [greater] than in the past. Being able to go into partnerships, being inter-culturally open, worldwide, to go into partnerships is an essential factor."

FRESH APPROACH

A further example of the collaborative approach can be seen in Poland, where LHT and GE Aviation have formally opened a jointly-owned overhaul centre for GEnx-2B and GE9X engines.

The XEOS facility, located in Sroda Slaska near Wroclaw, inducted its first engine in April and is set to service around 20 powerplants this year, LHT says.

Expected to be fully operational in 2023, the facility will have capacity to repair more than 200 engines a year and will "ultimately" employ about 600 people, or twice as many as today.

Pointing to the company's history of engine support capabilities, LHT chief executive Johannes Bussmann says that the new facility represents "a cornerstone for our long-term growth strategy to offer comprehensive MRO services also for the latest generations of aircraft engines".

Jean Lydon-Rodgers, chief executive of GE Aviation's services division, describes the XEOS facility as a "unique collaboration" with LHT. The MRO provider holds a 51% stake in XEOS, and GE the remainder.

Despite its success in attracting partners, Steinhoff believes collaboration is threatened by a proprietorial attitude towards data shown by certain manufacturers.

"We don't need any isolation of data, we don't need interest of excluding anyone out of the market, unless it is really for competitive reasons," Steinhoff says.

"If the OEMs want to join the market, competition is highly welcome. But it is not competition… because they are not giving access to their data. They are restricting data – so for me it is unfair competition," he adds. ■

Additional reporting by Cirium



XEOS engine overhaul centre is jointly owned with GE Aviation

GE Aviation

VENTURE

GREG WALDRON SINGAPORE

Partners launch first of-its-kind Vietnam facility

A component repair joint venture between Vietnam Airlines Engineering Company (VAECO) and ST Engineering has officially launched, becoming the first of its kind in the country.

"[Firming] the memorandum of understanding signed between VAECO and ST Engineering's aerospace sector in April 2018, the launch marks the establishment of the first and only aircraft component MRO joint venture in Vietnam to date," says the carrier.

Called Vietnam Singapore Technologies Engineering Aerospace (VSTEA), the business is sited within VAECO locations at Ho Chi Minh City and Hanoi airports. The partners had previously announced that ST Engineering would hold 49%, and VAECO 51%.

VSTEA will provide component MRO support to domestic and international airlines for aircraft including the Boeing 787, Airbus A320, A321, A350, and ATR 72.

It will also offer technical assistance with several other onboard systems, like avionics, hydraulics, wheels and brakes.

"Our partner – ST Engineering Aerospace – is one of the world's largest MRO service providers in terms of scale and development capability," says Vietnam Airlines chief executive Duong Tri Thanh.

"We believe this co-operation will bring significant benefits for both Vietnam Airlines and ST Engineering Aerospace in the growing aviation industry, and this joint venture marks the beginning of more fruitful achievements in the future."

ST Engineering president Lim Serh Ghee says that in addition to Vietnam Airlines being a major customer, VSTEA represents the company's first facility in Southeast Asia outside of its Singapore home. ■


Can you imagine the future is now?
Open. Modular. Neutral.
AVIATAR is the only operator-focused aviation platform developed with the knowledge and experience of leading airlines and MROs. The independent and fast-growing platform provides digital products and services through a wide range of applications – tailored precisely to your needs. Manage complex operations, increase aircraft availability, improve efficiency, save costs – all in one digital TechOps platform. Become part of a strong community and join us in shaping the future of aviation.
Visit our booth #1231 at the MRO Europe
GET IN TOUCH.
E-mail: info@aviatar.com
www.aviatar.com
www.lufthansa-technik.com
AVIATAR
by Lufthansa Technik

SUSTAINMENT **GARRETT REIM** LOS ANGELES

US Navy hits mission capability target

Commercial focus helps Super Hornet and Growler achieve readiness rate, but spare parts shortage hindering F-35

The US Navy's (USN's) fleet of Boeing F/A-18E/F Super Hornets and EA-18G Growlers have surpassed an 80% mission capability rate mandated last year by former defence secretary James Mattis, but its Lockheed Martin F-35Cs have missed the same target.

Last year, the USN said the mission capability rate for its F/A-18E/Fs and EA-18Gs was about 50%. The 80% goal required by September translates into 343 fighters and 95 electronic-attack aircraft, the service says.

Mission capability rates are the percentage of fleets classed as able to perform at least one assigned mission over a period of time.

The figure is deemed important as it gives the Department of Defense a rough understanding of how ready a given fleet of aircraft is to conduct combat missions.



US Air Force

Some 95 electronic-attack aircraft are deemed operationally ready

The USN says it has boosted mission capability rates by borrowing best practices from commercial industry. This has enabled improvements in periodic inspections and its process for component production and supply-chain data collection and circulation.

Speaking earlier this year, incoming defence secretary Mark Esper told the US Senate Armed Services Committee that the F-35 would fail to achieve the 80% benchmark, as a result of factors including a shortage of spare canopies.

This also affects the conventional take-off and landing A-model for the US Air Force (USAF), and the US Marine Corps' short take-off and vertical landing F-35B.

The USAF, meanwhile, expects its Lockheed F-16 fleet to have achieved the required mission capability rate target.

However, readiness for its Lockheed F-22 Raptors continues to suffer as a result of a lack of low-observable maintenance capacity, made worse by hurricane damage sustained at Tyndall AFB, Florida, in October 2018. ■



Boeing

Latest commitment takes service's Pegasus orders to 67 units

PROGRAMME **GARRETT REIM** LOS ANGELES

New contract fuels KC-46A fleet

Confirmed US Air Force (USAF) orders for the Boeing KC-46A Pegasus tanker have climbed to 67, after the service placed a $2.63 billion contract for its next 15 examples.

The lot 5 production deal includes funds for complete 767-based aircraft, plus two spare Pratt & Whitney PW4062 engines, five wing refuelling pod kits, spare parts, support equipment and related services.

Work on the latest batch of tankers is expected to be finished by March 2023.

Boeing has handed over 19 examples to the USAF since January 2019.

Despite having identified four so-called category one deficiencies with its replacement for the Boeing KC-135, the USAF plans to launch an initial operational test and evaluation phase with the new model later this year. ■

MUNITIONS **GARRETT REIM** LOS ANGELES

NAVAIR order supports APKWS II output boost

BAE Systems has secured a $2.68 billion contract via the US Naval Air Systems Command (NAVAIR) for an undisclosed number of Advanced Precision Kill Weapon System (APKWS) II upgrade kits.

The APKWS II is a semi-active laser guidance system that turns an originally unguided 70mm (2.75in) Hydra rocket into a precision strike weapon.

Detailing the award on 25 September, the US Department of Defense said production will be conducted for the US Air Force, US Army and US Navy, plus Foreign Military Sales customers Afghanistan, Australia, Iraq, Jordan, Lebanon, the Netherlands, the Philippines, Tunisia and the UK.

The contract covers production lots 8 through 12, although NAVAIR has not disclosed how many systems will be supplied. However, assuming the same $22,500 per-round price detailed for lot 7, the latest multi-year contract could cover about 119,000 kits. BAE has capacity to produce about 20,000 per year.

An APKWS II-equipped rocket can strike a target from a range of more than 1.6nm (3km), according to BAE.

The combination has so far been qualified for use from 13 aircraft types, including the Airbus Helicopters Tiger, Boeing AH-6M and AH-64D/E, Bell AH-1W/Z and UH-1Y, and Sikorsky UH-60L/M rotorcraft, plus the Boeing AV-8B Harrier II and Lockheed Martin F-16. ■



Indian ambitions dented by TAPAS UAV mishap
Defence P20

WEAPONS **GARRETT REIM** LOS ANGELES

USAF doubles JASSM production goal to 10,000

The US Air Force (USAF) is planning to increase production of Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM)-series weapons from a possible maximum of 4,900 units to potentially 10,000.

Up to 390 JASSM-ERs would be included in the service's lot 18 batch of production, followed by 400 in lot 19. A maximum rate of 550 units per lot would continue through lot 30, it says.

Production of a Long-Range Anti-Ship Missile version for the USAF and US Navy could also rise from a maximum of 110 to a possible 400, the air force says. The subsonic design has a maximum range of more than 500nm (926km).

In anticipation of growing demand, Lockheed in May 2019 broke ground on a new 20,900sq m (225,000sq ft) cruise missile production facility in Troy, Alabama. Construction work is scheduled for completion during 2021, with JASSM-ER manufacturing to ramp up in the second half of 2022. ■

EVENT **GREG WALDRON** SINGAPORE

China celebrates with show of strength

Flypast with three H-6Ns headlines military parade as more than 100 aircraft mark communism's 70th anniversary

Beijing used commemorations to mark the 70th anniversary of communist rule in China to display an impressive array of firepower on 1 October.

Involving 15,000 personnel, hundreds of vehicles and more than 100 aircraft and helicopters, its military parade was conducted under tight security.

As with previous such events, while state authorities had worked to reduce local emissions over recent weeks, smog hung in the air of the capital.

Among the aviation highlights was an appearance by the upgraded Xian H-6N bomber, which has received updates including an air-to-air refuelling probe. Given a sufficient number of People's Liberation Army Air Force (PLAAF) tankers, this would allow the type – which is focused on anti-shipping missions – to operate across an increased area.

A trio of H-6Ns involved in the flypast each carried four air-launched cruise missiles – pairs of CJ-10s and KD-63s – across their six external hardpoints.

Another innovation appears to be the removal of the internal bomb bay on some examples, to create a concave belly. Online speculation suggests that this will allow the strike platform to carry the DF-21D anti-ship ballistic missile beneath its centreline.

"If [ballistic missile speculation] is correct, then this would be an impressive anti-ship stand-off capability for the PLAAF, which would extend the utility of the DF-21D well beyond the first island chain," says Malcolm Davis, senior analyst, defence strategy and capability at the Australian Strategic Policy Institute.

"That would theoretically match the ground-launched DF-26 [intermediate-range ballistic missile] anti-ship capability, and increase the risk for US aircraft carrier battlegroups to penetrate inside the second island chain," Davis notes. "The Chinese are clearly trying to make it costlier for the US to project power into the western Pacific, to the point where the US simply chooses not to intervene in a crisis around Taiwan, for example."

The flypast also featured five Chengdu J-20s, although an earlier image taken during one of the event's practice sessions showed seven examples in formation. Other participating fighters included the Chengdu J-10, plus the Shenyang J-11 and the navy's J-15 carrier-based variant. Multiple airborne early warning and control system assets took part, including the Shaanxi KJ-500 and KJ-200A and Ilyushin Il-76-based KJ-2000.

A variety of helicopters and support aircraft also appeared, including six examples of the Harbin Z-20, which is visually similar to Sikorsky's UH-60.

Beijing also highlighted its unmanned combat air vehicle ambitions. An AVIC Sharp Sword flying-wing design – believed to be a mock-up – was shown mounted on a truck; other vehicles carried a pair of black, delta-winged models.

Images of the Sharp Sword first emerged in 2013, with reports indicating that it has undergone flight tests. It is not clear what the type's intended mission is, but the parade revealed that its designation is GJ-11. ■



Michael Schiefelbein/AP/Shutterstock

GJ-11 Sharp Sword design showcased Beijing's UCAV programme



Ng Han Guan/AP/Shutterstock

Upgraded strategic bomber carried CJ-10 and KD-63 cruise missiles

UNMANNED SYSTEMS **MIKE RAJKUMAR** BENGALURU

Indian ambitions dented by TAPAS UAV mishap

The recent loss of a "Rustom II" medium-altitude, long-endurance (MALE) unmanned air vehicle (UAV) during experimental flight trials is a setback for an ambitious programme of India's Defence Research & Development Organisation (DRDO).

A developmental prototype of the formally named Tactical Advanced Platform for Aerial Surveillance Beyond Horizon-201 (TAPAS 201) crashed soon after taking off from the DRDO's Aeronautical Testing Range located at Chitradurga, approximately 135nm (250km) northwest of Bengaluru.



DRDO

MALE type has operating altitude of 30,000ft and can carry 350kg

According to the DRDO, a new configuration was being tested when the crash took place. Flight data is being analysed to ascertain the causes of the loss, it adds.

Images circulated in local media of the crash site show a badly damaged UAV with "TAPAS-04-19" markings.

The MALE design features lofty specifications, such as an operating altitude of 30,000ft, a service ceiling of 32,000ft and the ability to take off from runways as high as 11,000ft. The 2t-class type will be able to carry a payload of 350kg (770lb) and undertake intelligence, surveillance and reconnaissance missions for the Indian air force, army and navy.

As part of developmental trials, TAPAS 201 prototypes have previously demonstrated a maximum endurance of 1h 15min, a range of 21nm and an altitude of 14,200ft. Testing of a higher-powered engine commenced in February 2018, as user configuration flight trials started.

There are thought to have been a total of six TAPAS 201 prototypes flying. ■

DEVELOPMENT **GREG WALDRON** SINGAPORE

KF-X takes shape following key review

KAI's twin-engined fighter moves on to prototype phase as Defense Affairs Agency agrees it meets all requirements

Seoul has completed the critical design review (CDR) of the Korea Aerospace Industries (KAI) KF-X fighter, setting the stage for a prototype to be rolled out in the first half of 2021.

The twin GE Aviation F414-engined type will make its flight debut in the first half of 2022, with development work to conclude by 2026, South Korea's Defense Acquisition Program Administration (DAPA) says.

A full-sized mock-up will be displayed at the Seoul International Aerospace and Defense Exhibition this month.

The CDR announcement followed a 24-26 September meeting held by Seoul's Defense Affairs Agency, which concluded that the proposed jet will meet "all requirements reflected in the initial product specification".

"In this detailed design review meeting, reviewers composed of government and civilian experts, including the air force, reviewed about 390 technical data [points] to ensure that the military requirements were properly reflected in the design," DAPA says. This followed earlier work including analysis, windtunnel tests, and refinement of systems.

A separate CDR was conducted earlier this year regarding the fighter's active electronically scanned array radar. Hanhwa Systems has developed a prototype with assistance from Israel's Elta Systems, with Seoul's Agency for Defense Development (ADD) to be involved in airborne testing.



Korea Aerospace Industries

South Korean experts considered about 390 technical data points

As currently envisaged, the KF-X should be on a par with advanced versions of the Lockheed Martin F-16.

The ADD and KAI are leading the $7.2 billion KF-X project, with Indonesia also holding a 20% share. However, the DAPA statement makes no mention of Jakarta or its intended I-FX variant.

In July it emerged that Jakarta was pressing for price concessions, potentially seeking a contra deal involving Indonesian-produced defence equipment. ■

See Feature P32

Download the 2019 World Air Forces Report
www.flightglobal.com/waf
FlightGlobal
IN ASSOCIATION WITH
Together ahead. RUAG



Farnborough air show home sold to asset manager MIRA
Business Aviation P23

ROTORCRAFT GREG WALDRON MCAS FUTENMA

Marine stalwarts kept ready for action

Enhancements to trusty Bell models offer US service greater assault options at strategic Asia-Pacific base in Okinawa

Some names stick. While Bell designates the latest incarnation of its venerable attack and utility helicopters as the AH-1Z Viper (also referred to as the "Zulu") and UH-1Y Venom, the US Marine Corps (USMC) personnel of HMLA-169 squadron prefer the names their fathers and uncles used for the original models during the Vietnam War: Cobra and Huey.

"I wasn't sure what you guys meant when you kept talking about the Zulu," a young marine told journalists during a recent visit to MCAS Futenma on the Japanese island of Okinawa. "We call it the Cobra."

Futenma buzzes with activity, as maintainers work on a small fleet of AH-1Zs and UH-1Ys. Across the tarmac, a sister marine squadron works on a row of Bell Boeing MV-22 Osprey tiltrotors.

Strategically located between Japan and Taiwan and relatively close to another key ally, South Korea, Okinawa is a linchpin of US strategy in the Asia-Pacific region, with several other US and Japanese bases on the island, including Misawa and Naha.

COMMON PARTS

Despite strikingly different silhouettes, the AH-1Z and UH-1Y have 85% commonality, making them easier to support at austere bases or aboard cramped amphibious assault ships. This includes using GE Aviation T700 engines and composite rotor blades.

Following sales successes in Bahrain and the Czech Republic, Bell has high hopes for both models in the Asia-Pacific region, where it sees potential sales opportunities in Australia, Japan, New Zealand, the Philippines, South Korea and Thailand.

Bell stresses that its H-1 models are marinised at the point of manufacture, arguing that this is essential to ensure continued operations in challenging littoral and maritime environments.



Greg Waldron/FlightGlobal

AH-1Zs deployed to MCAS Futenma train for amphibious assault

They are also hardened against the electromagnetic interference produced by warships' radars and communication systems.

Packed with advanced sensors, the AH-1Z has a maximum gross weight of 7,970kg (18,100lb); one-third greater than the W-model version it is replacing in USMC service. It can carry 16 Lockheed Martin AGM-114 Hellfire air-to-surface missiles, as well as a pair of Raytheon AIM-9 Sidewinder air-to-air missiles and has a chin-mounted 20mm rotary cannon.

Captain John Kelly is a seasoned AH-1Z pilot. He estimates that 70-80% of HMLA-169's training involves a simulated amphibious assault scenario, with the service placing a premium on operating at night and in difficult conditions.

First, USMC Lockheed F-35Bs would eliminate an enemy's air defences and provide support on the electromagnetic spectrum. Then AH-1Zs would make their entrance, using a mix of Hellfires, 70mm (2.75in) rockets and cannon fire to engage tanks, vehicles and personnel. Kelly notes that a two -helicopter "section" of AH-1Zs can destroy up to 30 tanks.

The gunships would be followed by UH-1Ys deploying an initial force of marines to secure a landing zone. Armed with a mix of door guns and rockets, these would remain in the vicinity, along with AH-1Zs, to provide fire support. A final wave would come in the form of V-22s transporting up to 24 marines each.

Pilots swap between the front and back seats of the AH-1Z, as their night-vision goggle-compatible glass cockpits are virtually identical. This improves the chances of the attack helicopter completing its mission, should a crew member become a casualty.

ADAPTABLE

While the UH-1Y lacks the sheer firepower of its attack helicopter sibling, pilot Captain Shawn Leighton likes the variety of missions that the utility type can operate. These range from transporting troops and cargo to performing combat search and rescue missions.

He describes the UH-1Y's operating environment as "dynamic", with two pilots supported by a pair of crew chiefs also manning a door-mounted 7.62mm minigun and .50cal machine gun.

Leighton reckons the crew's most challenging mission is rescuing a downed pilot, owing to the rapid response nature of such operations. This involves coordinating with AH-1Zs, as well as fixed-wing aircraft that can provide fire support. For rescue missions, he says, the crew must "make sure we are not falling into a trap". When they make contact with the rescue subject, it is essential to confirm his or her identity before departing.

The arrival of BAE Systems' Advanced Precision Kill Weapon System (APKWS) laser guidance kit for standard 70mm rockets has given the UH-1Y its first precision-strike weapon. APKWS rounds are also carried by AH-1Zs, in a pair of 19-round rocket pods. However, despite the weapon's precision, both Kelly and Leighton say unguided rockets still have utility for the USMC, especially for quickly engaging a target that appears suddenly.

Marines at Futenma gave high marks to the AH-1Z and UH-1Y models for their sustainment on land and at sea, noting that their main rotors can be folded and unfolded within minutes, optimising storage aboard ships and in hangars.

"I always tell people to talk to the US Marines to see how their experience is with the AH-1Z and UH-1Y," says Victor Chin, Bell's Singapore-based senior manager, global military sales and strategy. ■



Greg Waldron/FlightGlobal

Folding main rotors makes storing Venom a straightforward task

PROGRAMME **KATE SARSFIELD** LONDON

SyberJet readies SJ30i for first flight

Relaunched high-speed jet will debut at NBAA, with upgraded successor progressing towards 2022 service entry

SyberJet is readying the first SJ30i for its maiden sortie in the coming weeks, and will debut the aircraft, along with a full-scale interior mock-up, at the National Business Aviation Association convention and exhibition in Las Vegas from 19-21 October.

The high-speed light-twin is an upgraded version of the SJ30-2, which was certificated in 2005 by its former owner, Emivest Aerospace. Four examples were delivered and remain in service.

SyberJet parent MTI, whose subsidiary Metalcraft Technologies was the aft fuselage supplier for the aircraft, acquired the programme in 2011.

Serial number 5 (N50SJ) is "the experimental aircraft used on the original certification programme", says Mark Fairchild, vice-president customer experience.

He says the company has completed high-power engine runs and initiated power-on taxi testing. "We aim to begin flight testing on 5 October," says Fairchild.

The SJ30i replaces its predecessor's Honeywell Primus Epic control display system with a bespoke flightdeck based on the Epic 2.0 cockpit. Dubbed SyberVision, the suite offers four 12in displays, SmartView synthetic vision, a moving map display system, graphical flight planning and onboard weather radar, as well as dual flight management systems.

SyberVision also meets automatic dependent surveillance – broadcast out requirements, which will become compulsory in the USA and Europe from January and June 2020, respectively.

The Williams International FJ44-2A-powered SJ30i also has a redesigned lightweight interior.



SyberJet Aircraft

Four examples of SJ30-2 have been operating since their 2005 debut

The SJ30i fleet will consist of the five unsold and incomplete units that MTI acquired from Emivest. The first example of the $8.3 million aircraft will be delivered following certification, scheduled for the first quarter of 2021.

Meanwhile, SyberJet is working on the new standard version of the jet powered by more fuel-efficient, higher-thrust FJ44-3AP-25 turbofans with dual FADEC controls.

Scheduled to enter service in 2022, the SJ30x will provide a variety of performance benefits including higher cruise speed at altitude, faster climb, more payload, and better hot-and-high performance, says Fairchild. The $8.8 million aircraft will also feature single-point refuelling. ■

DEVELOPMENT **KATE SARSFIELD** LONDON

Cessna Longitude and Caravan EX hit milestones

Textron Aviation has delivered the first Cessna Citation Longitude business jets, with the shipments in early October signalling what the US manufacturer describes as "the start of a new dimension in business travel".

The super-midsize, clean-sheet Longitude was launched in 2012 as Cessna's flagship product and secured US Federal Aviation Administration type certification on 21 September. "We are thrilled to now transition this programme into service," says Textron Aviation chief executive Ron Draper.

Powered by two 7,660lb (34.1kN)-thrust Honeywell HTF7700L turbofan engines, the Garmin G5000-equipped jet has a maximum cruise speed of 480kt (900km/h) and a range of 3,500nm (6,500km). The fly-by-wire Longitude has a 5,950ft cabin altitude for "passenger comfort", and the "longest maintenance intervals in its class", at 800h or 18 months, says Textron.



Textron Aviation

Clean-sheet design gained US type certification on 21 September

Meanwhile, the airframer has delivered the 500th Cessna Grand Caravan EX, with the landmark aircraft (N795J) handed to South Aero, a family-owned charter operator and long-time customer based in Albuquerque, New Mexico.

Textron has achieved the delivery milestone in a little less than six years, having shipped the first example in early 2013.

Launched in July 2012, the EX is the third variant of the all-metal, high-wing 208 Caravan – introduced in 1984 – and the second iteration of the Grand Caravan, a stretched version of the 208, which arrived four years later.

Textron replaced the predecessor's 675hp (500kW) Pratt & Whitney Canada PT6A-114A engine with an 870hp PT6A-140. This delivers a 38% improvement in the EX's rate of climb, and a 12kt boost in its cruise speed, to 195kt.

Cirium fleets data shows North America as having the largest inventory of EXs, with more than 50%, followed by Asia-Pacific, with 20% and Latin America with 15%.

The $2.7 million type – which has an optional under-belly cargo pod – seats between 10 and 14 passengers, has a useful load of 1,670kg (3,690lb) and a maximum range of 960nm. ■



Rising pressure
Cover Story P25

SALE **KATE SARSFIELD** LONDON

Farnborough air show home sold to asset manager MIRA

Business aviation airport outlines plans to develop offering with backing of new owner

TAG Aviation is continuing to divest assets with the sale of the UK's only dedicated business aviation airport, TAG Farnborough, to Australia's Macquarie Infrastructure and Real Assets (MIRA).

The disposal to MIRA comes around seven months after the Swiss business aircraft services company sold its European MRO to Dassault Aviation.

The former military facility, home to the biennial Farnborough air show, was taken over by TAG in 2001 and extensively rebuilt with an iconic hangar and terminal building. To date, the Geneva-headquartered firm has invested more than £150 million ($184 million) to turn the site into one of the leading business aviation hubs in Europe.

Located around 35 miles (55km) southwest of London, TAG Farnborough has seen its annual movements soar from 16,000 in 2003 – it first full year of operation – to 31,000 in 2018, marking an annual record for the site. Farnborough has an annual ceiling of 50,000 take-offs and landings, which it expects to hit in 2022 based on the current rate of growth.



TAG Farnborough

UK hub logged a record 31,000 take-offs and landings during 2018

"The significant investment that has occurred at Farnborough airport over the past two decades under the previous shareholders has been transformative," says Brandon O'Reilly, who has served as the site's chief executive since 2006. "With a number of development projects already under way, we are excited to partner with Macquarie to further develop our offering to the business aviation market."

These projects include Gulfstream's new 20,400sq m (220,000sq ft) European service centre, located at the eastern end of the airport.

MIRA, owner of the Atlantic Aviation chain of fixed-base operations in the USA, says: "We look forward to partnering with Farnborough airport to ensure it remains an important contributor to the local economy and a business aviation gateway to London and the Southeast." ■

INVESTMENT
GREG WALDRON
SINGAPORE

Marubeni joins JAL in business jet charter deal

Japan Airlines (JAL) and Marubeni have launched operations for a business jet venture focused on arranging charter flights.

The flag carrier announced the new start-up in January, with a paid-up capital of Y150 million ($1.36 million). JAL owns 51% of the venture, known as JAL Business Aviation (JALBA), with Marubeni owning the remaining 49%.

JALBA is offering three types of charter service: domestic, international, and connecting flights, which are a mix of JAL scheduled flights and business charters. As an example, JAL says passengers on a commercial service from Tokyo to London could be transferred to JALBA business jet charter service to Bologna, Paris, or Toulouse before returning to Tokyo on the scheduled route.

To facilitate the operation, JALBA has appointed Jet Aviation to arrange flight and crew coordination, hangars, and maintenance. ■

MILESTONE **JON HEMMERDINGER** BOSTON

US and European regulators validate Praetor 500

Embraer has secured US and European type certifications for the Praetor 500, less than a year after the midsize business jet was launched.

The certifications follow August approval for the nine-passenger aircraft by Brazil's ANAC civil aviation authority.

Embraer has moved fast with development and certification of the Praetor family, which also includes the 12-passenger Praetor 600.



Embraer

Type has been approved by Brazilian authority ANAC since August

The company announced it was developing the pair, which are derivatives of the previous-generation Legacy 450 and 500, at the National Business Aviation Association convention and exhibition in October 2018.

Embraer first moved the $20 million Praetor 600 through certification, with regulators from Brazil, Europe and the USA validating the aircraft by May. To date, the Brazilian airframer has delivered six examples of the super-midsize type.

Praetors have the same fuselage and wing as their predecessors, but their Honeywell HTF7500E powerplants produce an additional 500lb (2.23kN) of thrust.

Praetors also carry more fuel than the Legacy models, giving them more range, according to Embraer.

With four passengers, the $17 million Praetor 500 can fly up to 3,340nm (6,190km) and the Praetor 600 more than 4,000nm, Embraer says. ■

FlightGlobal

Aerospace Big Data Barcelona

5-6 December 2019 | Barceló Sants Hotel

Next generation of MRO efficiency

The conference gathers the MRO ecosystem including OEM's, data and IT experts to discuss advancements in predictive maintenance strategies and how airlines can best utilise data and emerging technologies to maximise the benefits of predictive maintenance.

Industry experts will discuss the evolving landscape and opportunities for the future including how we work 'smarter' with all the digital elements and ensure parts are received on time.

Attendees will gain new insights on the ever-evolving cybersecurity threats as well as take practical solutions around scalability challenges e.g. workforce shortages and technology investments.

Speakers confirmed:



Jack Giovanini
Data Scientist
Alaska Airlines



Borja Dosal Roiz
Avionics & Electrical System Technical Engineering, **Etihad Airways**



Wolfgang Henle
Managing Director
Austrian Airlines Technik



Wanda Manoth-Niemoller
Commercial Development Manager, Training Engineering & Maintenance, Air France, **KLM**

Find out more: flightglobal.com/bigdata



Airlines won't 'get out of bed for less than 99.5% reliability'

Pius Kollerimage/BROKER/Shutterstock

RISING PRESSURE

Powerplant makers face conflicting demands for performance, reliability and huge production rates – as revealed in our semi-annual survey of the market for commercial aircraft engines

MAX KINGSLEY-JONES LONDON

It is a measure of the engine manufacturers' troubled times that their recent appearance on a panel at a major industry conference was rocked by calls from delegates to apologise for failing to deliver on their promises.

The event was the European round of ISTAT in Berlin, which brought together some of the airframe and engine OEMs' most important clients – the leasing and financing community. And although Emirates Airline president Tim Clark was absent, his recent criticism of engine manufacturers – and to a lesser extent airframers – echoed around the auditorium on several occasions.

"I'm a little bit irritated that over the years we as an airline, and the industry, have been subjected to the requirements of the propulsion manufacturers, and to an extent the airframe manufacturers, where we are expected to deal with quality-control issues, design issues etc, and operate these aircraft and engines and take whatever consequences there are when they don't work," he said in September.

Airlines are unwilling to get out of bed for anything less than "99.5%" dispatch reliability, says Clark: "We are not in a business to deal with aircraft that don't function properly."

The main recipients of Clark's criticism were the GE Aviation GE9X and the Rolls-Royce Trent 1000. The former should already be powering the Boeing 777-9 on its flight-test programme but has instead caused a major delay amid a redesign of its high-pressure compressor. The latter's ongoing turbine blade issues have severely disrupted operations of R-R's 787 customers.

Speaking at ISTAT, senior marketing director Chris Nye said GE "hopes to get the [revised] engines tested and certified this year". This will be crucial to enable the 777-9 to fly as early as possible in 2020.

MOVING PARTS

The stark reality for the airframe manufacturers is that, for all the new materials and electronic wizardry they pack into their next airliner programme, it is the moving parts hanging off each wing that always deliver the big step in efficiency – and therefore performance.

So when the airlines exert their pressure on the likes of Airbus and Boeing to deliver more range with lower operating costs and a competitive price tag, it is the likes of GE, Pratt & Whitney and R-R that shoulder the major burden of delivering that performance.

It should be no surprise then that all of the big three powerplant manufacturers have been struggling to deliver the sort of service readiness that Clark insists their customers should deserve. And they are often trying to achieve this at eye-watering production rates that were unheard of until recent times.

CFM International chief executive Gael Meheust points out that the engine maker is producing "40-45" Leap engines a week. P&W marketing director Paul Finklestein says the ramp-up on the geared turbofan (GTF) has been "five times as fast" as its previous single-aisle powerplant, the V2500.

"Does that mean that things we found on the V2500 in 10 years we're finding out on the GTF in two years? [Possibly]… but the maturity rate is much, much faster," says Finklestein. "If we had delivered the GTF on the same production path as the V2500-A1, then only about 10% of the problems that we've found and fixed today would have emerged."

But the consequences of these high rates are double-edged. As the volumes of in-service engines balloon quickly, the risk of major disruption when a problem is identified can be much larger. That is a dilemma facing all the stakeholders – as many have discovered to their cost in recent years. ■

CFM International

DOMINIC PERRY LONDON

CFM International, the Safran-GE Aviation joint venture, is powering ahead with production of its new Leap-series engines – which span the 23,000-35,000lb (102-155kN)-thrust range – as the transition away from the legacy CFM56 gathers pace.

In the first half of 2019, CFM delivered 861 Leap powerplants and 258 CFM56s, compared with respective figures of 438 and 591 for the same period a year earlier. The joint venture is on target to ship 1,800 Leap engines this year, as narrowbody production continues at record levels.

That output rate has been maintained, relatively speaking, despite the problems with Boeing's 737 Max, which is exclusively powered by the Leap-1B. Although the re-engined single-aisle has been grounded since March, production has continued, albeit at a lower rate of 42 aircraft per month – requiring the weekly delivery of around 20 engines – rather than the previous rate of 52 per month.

In fact, the propulsion specialist had been preparing to support production of 57 aircraft per month when flights with the 737 Max were suspended. "Of course, the ramp-up is not as high as we were expecting at the beginning of the year, but it is temporary," says Safran chief executive Philippe Petitcolin. "The day the airplane is back in the air Boeing will be pushing us back into production ramp-up."

However, the gentler ramp-up has enabled CFM to get on top of supply-chain issues, notably with forgings and castings, which slowed production of both in-service Leap variants at the end of 2018. "Production which is not growing at the level we were expecting means we have less pressure coming from our supply chain to meet our demand," says Petitcolin.

Although minor "issues" continue to crop up, he says, over the "last two to three months" there has not been "huge pressure coming from deliveries of forgings and castings that could be late".

As of 30 June, 44 airlines were operating 454 Leap-1A-powered Airbus A320neo-family jets and had accumulated 3.3 million flight hours; the Leap has a 61% market share on the re-engined narrowbody, says Safran.

Meanwhile, at the point the type was grounded, 54 airlines were flying 389 737 Max jets, which had amassed 1.7 million flight hours. Petitcolin describes the Leap family as "the most reliable engine of its generation". ■



Gary He/EPA-EFE/Shutterstock

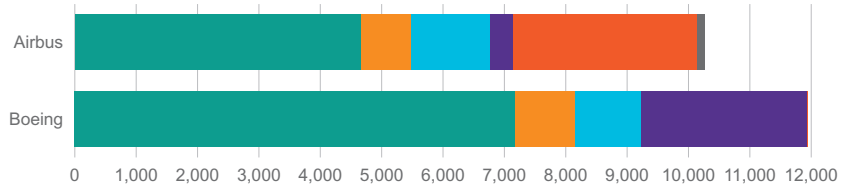
Lower 737 Max production rate has allowed engine maker to tackle supply-chain issues

CFM International

Engine family	Aircraft type	Aircraft in service	Aircraft in storage	Aircraft on order
CFM56	A320ceo family	4,083	149	70
	737NG	6,447	113	9
Leap	A320neo family	490	5	2,522
	737 Max	0	383	4,399
	C919	0	0	305

Source: Cirium fleets data (17 September 2019)

Airbus/Boeing in-service fleet by engine manufacturer



Notes: In-service fleet at 1 May 2019. Boeing data includes former MDC types. A total of 383 CFM Leap-powered 737 Max aircraft were stored on 1 May 2019 and do not appear here. Source: Cirium fleets data (September 2019)

CFM International | Pratt & Whitney | Rolls-Royce
GE Aviation | International Aero Engines | Engine Alliance

1,800
Projected 2019 Leap powerplant output

GE Aviation

JON HEMMERDINGER BOSTON



Public Address/Action Press/Shutterstock

GEnx turbofans, which power 747-8, have continued to demonstrate sales success

GE Aviation is under continued pressure to fix an issue with the GE9X's high-pressure compressor, which Boeing says has further delayed the first 777X flight. However, the Peebles, Ohio-based engine maker insists it has fixed the issue and is preparing to conduct additional tests, while Boeing has shifted the 777X's first flight into early 2020.

GE9X development apparently progressed relatively smoothly through much of the programme, although during earlier testing the company did redesign a "stator vane lever arm" to address faster-than-expected wear. The company says the huge turbofan broke a thrust record for commercial aircraft engines several years ago when its engineers measured 134,300lb (597kN)-thrust. The engine has accumulated some 400h of flight testing, GE says.

But a major issue became apparent at the Paris air show in June when GE Aviation chief executive David Joyce revealed his team was redesigning a stator in the GE9X high-pressure compressor. The issue caused hotter-than-expected exhaust gas temperature and premature deterioration, he said. "The component has been redesigned and GE is preparing for engine testing", GE tells FlightGlobal. "GE Aviation remains aligned with Boeing on this effort."

Boeing has announced that the 777X will first fly in the first quarter of 2020, not in 2019 as originally planned, because of the issue. The airframer says it still expects to begin deliveries in 2020, but some analysts doubt the 777X will enter service until 2021. Boeing could release more information when issuing its third-quarter financial results on 23 October.

Leaving these issues aside, GE has a healthy backlog, with more than 700 GE9X engines on order with eight future 777X operators, it says. The 777X has not been a massive seller – Boeing holds 344 firm orders – but the airframer and industry analysts expect commitments to materialise next decade as airlines begin their next phase of fleet renewals.

GE continues to see sales success elsewhere, having sold some 2,500 GEnx turbofans, which power 787s and 747-8s. More than 1,700 of those powerplants are now flying, GE says. GE also co-owns CFM International, which makes the Leap line of turbofans for 737 Max and Airbus A320neo-family aircraft.

Meanwhile, GE is eyeing future engine development, studying means to improve engine efficiency through advanced materials, while looking further afield at electric-based propulsion systems. Its next project remains unclear, and the company says it is studying a variety of engine architectures. But executives have hinted that GE will primarily focus on improving engine thermal efficiency – how well an engine converts chemical energy in fuel to mechanical energy. CFM's prime competitor, Pratt & Whitney, has taken a different tack, targeting better propulsive efficiency through the use of a fan gear in its PW1000G engines.GE hints that its next engine will include more components made through additive manufacturing (also called 3D printing) and from advanced materials like ceramic matrix composites (CMCs), which can enable engines to run hotter. GE operates the Additive Technology Center in Ohio and has some 1,000 engineers and scientists working on the technology. The company has also invested $1.5 billion in the past decade on CMCs and has two US CMC production facilities.

GE says it is also "aggressively researching hybrid-electric and electric propulsion" systems for aircraft. The company is evaluating such technology at its Electrical Power Integration Centre in the UK and the Electrical Power Integrated Systems Center in Ohio. ■

GE Aviation

Engine family	Aircraft type	Aircraft in service	Aircraft in storage	Aircraft on order
CF34	ARJ21	12	3	335
	CRJ	1,249	292	32
	E-Jet	1,417	62	190
GE90	777-200/300	1,145	37	96
GEnx	747-8	124	0	19
	787	540	5	316
GE9X	777-8/9	0	0	344

Source: Cirium fleets data (17 September 2019)

$1.5bn

Sum invested in CMCs over past 10 years

Pratt & Whitney

JON HEMMERDINGER BOSTON

Nearly four years have passed since Pratt & Whitney's first geared turbofan (GTF) entered service. Although those years brought several high-profile engine issues, P&W says it has addressed the problems and that GTFs are proving their mettle by achieving fuel-saving expectations.

Meanwhile, the engine maker continues working to reduce GTF manufacturing costs while boosting production – no easy task as the industry struggles with supply-chain shortages. "It's delivering all of the fuel-burn savings, noise improvements [and] emission improvements that we've committed to," P&W vice-president of commercial aircraft engineering Amy Comer says of the GTF. "A lot of the reliability improvements we have put into the product are really taking hold."

The GTF entered service in early 2016 when Lufthansa began operating a PW1100G-powered Airbus A320neo. P&W makes GTF variants for A220s, the Embraer E-Jet E2 family and in-development Mitsubishi Aircraft SpaceJet range and Irkut MC-21s.

As of August, 527 GTF-powered aircraft were flying globally with 38 operators. P&W's GTF backlog stands at more than 10,000 engine orders and commitments, the company says. P&W insists it remains on track to meet 2019 delivery commitments – even though production has not hit the originally expected levels.

Just a few years ago, the chief executive of P&W parent United Technologies predicted that GTF deliveries would hit 1,200 a year by 2020. In the first half of 2019, P&W shipped 362 "large commercial" aircraft engines, a category that includes GTFs and several older-technology powerplants.

Engine issues and supply-chain shortages have challenged production. "Casting and forgings, from an industry perspective, are going to be one of the bottlenecks for a long time," Comer says.

P&W has brought another forging press online, which is manufacturing turbine disks and compressor rotors, and expects to have forging capacity to meet demand until 2021, Comer says. Problems with accessory gearboxes, low-pressure turbines and knife-edge seals in high-pressure compressors have affected in-service GTFs. Airbus halted deliveries of PW1100G-powered A320neo-family aircraft in early 2018 after several in-flight shutdowns.

Just weeks ago, US regulators required operators to address potential oil leaks affecting the A220's PW1500Gs and the E-Jet E2s' PW1900G. But Comer insists: "All of the significant service interruptions have been addressed from a design solution perspective." She says new GTFs have fixes, although some 1,000 in-service engines must be updated.

Despite hiccups, Comer says the engines are performing well, with the PW1100G's dispatch reliability hitting 99.96%. "The engine is getting pretty close to world class in terms of dispatch reliability,"

she says.P&W's future engines will likely include more advanced materials such as ceramic matrix composites and the company is developing hybrid-electric engines. But Comer says the GTF architecture is here to stay because it can be scaled to create new engines for narrowbodies or widebodies, including Boeing's proposed New Mid-market Airplane.

"The geared turbofan is not going anywhere," Comer says. "It's going to be the core of any future product development that we do." ■

Pratt & Whitney

Engine family	Aircraft type	Aircraft in service	Aircraft in storage	Aircraft on order
PW1000G	A220	84	5	426
	A320neo family	445	6	1,417
	E-Jet E2	9	1	163
	MC-21	0	0	83
	SpaceJet	0	0	213

Source: Cirium fleets data (17 September 2019)



PW1100G-powered A320 deliveries were paused in early 2018 after in-flight shutdowns

Caroline Blumberg/EPA/Shutterstock



Stanislaw Kowalczuk/Shutterstock

Trent 1000-related groundings should largely be resolved by end of second quarter 2020

Rolls-Royce

DOMINIC PERRY LONDON

At Rolls-Royce, the big three programmes are the Trent 1000, 7000 and XWB, which are performing with varying degrees of success. On the positive side of the ledger is the Trent XWB that powers the Airbus A350. Production is matching the airframer's requirements and the in-service performance of the powerplant is where it should be. The engine is "operating very reliably with 27 airlines around the world", says R-R chief executive Warren East.

Available in three variants – the derated 78,900lb (351kN)-thrust XWB-75, the 84,200lb-thrust XWB-84 and the 97,000lb-thrust XWB-97 – the powerplant is a "driver" for engine flying hour growth and unit cost reduction, East says. As of 30 June, XWB engines accounted for 11% of the fleet, with this only set to grow as the "largest-volume engine coming out of Rolls-Royce over the next several years". Breakeven is forecast by end-2020.

With the A330neo-powering Trent 7000 – the exclusive powerplant for the re-engined widebody – things are also looking up after an initial slow start. Service entry for the long-haul twinjet was delayed by hold-ups to the programme in late 2018, but during the first half of 2019, R-R shipped 54 of the engines to Airbus, a performance East describes as a "big turnaround" for the programme. R-R is now "comfortable" with its status, he says.

With only 26 A330neos in service, operational feedback and reliability data is limited, however.

But causing the most sleepless nights in Derby at the moment is the Trent 1000 for the Boeing 787. While R-R now appears to have a better handle on the premature deterioration issues that have plagued the engine, disruption for operators is continuing. This was illustrated by an August incident in which parts from a Trent 1000 were scattered over Rome when two intermediate-pressure turbine blades fractured.

Although R-R had promised that the number of aircraft grounded as a result of the issues with turbine and compressor blades would be in single figures by year-end, it has since revised that to the second quarter of 2020. Package B and C engines are affected, as well as the Trent 1000 TEN, the newest variant of the powerplant.

For R-R and its customers, the fear had always been that the problems on the Trent 1000 would also manifest on the XWB and 7000 models. But speaking in late May, R-R chief customer officer Dominic Horwood said that the blade-deterioration issue had not been seen on other engines. "We are confident that what we are dealing with on the Trent 1000 are design issues which are unique to that product and they are related to the specific configuration, the specific design of that engine at a component level," he says.

Horwood says that lessons learned from the experience are being incorporated into the manufacturer's design and testing processes for the future, including a better understanding of the corrosive sulphidation process at the root of the blade cracking. ■

Rolls-Royce

Engine family	Aircraft type	Aircraft in service	Aircraft in storage	Aircraft on order
Trent	A330ceo	800	34	15
	A330neo	26	1	221
	A350	294	8	606
	A380	105	2	33
	777-200/300	164	29	0
	787	305	29	141

Source: Cirium fleets data (17 September 2019)

54

Trent 7000s delivered to Airbus, first half of 2019



Early versions of C919 will be powered by Leap-1C

Imaginechina/Shutterstock

China

ALFRED CHUA SINGAPORE

When Chinese airframer Comac's C919 was still being developed as a competitor to Boeing's 737 and the Airbus A320, much was said about a "home-made engine" for a home-grown aircraft. But more than two years later, the fanfare has died down, even as the C919 continues test flights and looks poised to enter service with Chinese carriers – minus the Chinese engines, for the time being.

The prototype of the CJ-1000AX, the alternative powerplant manufactured by Chinese engine maker AVIC Commercial Aircraft Engine (ACAE), was first publicised in December 2017, after 18 months of assembly. ACAE had signed a deal with Comac a year earlier to supply engines to the narrowbody programme.

The CJ-1000AX was touted as the "home-made engine" by the state-owned *Global Times* newspaper that would "replace imported foreign engines in future". The C919 will initially be powered by CFM International Leap-1C engines.

Last May, the CJ-1000AX hit a milestone in its development when it achieved power-on. The high-bypass-ratio turbofan engine's core reached a maximum speed of 6,600rpm, according to Chinese officials.

FlightGlobal has previously reported that China plans to build 24 more CJ-1000 prototype engines to support an airworthiness campaign, with entry into service targeted after 2021.

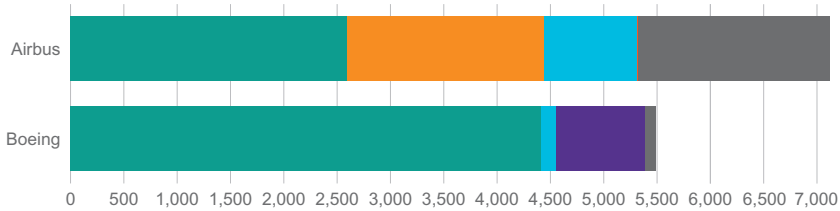
Citing an Aero Engine Corporation of China (AECC) researcher, *Global Times* painted a bright future for the turbofan: "The CJ-1000 is designed for the C919, but is expected to power the Boeing 737 or Airbus A320 or a similar newly built aircraft in the world market by 2025."

Meanwhile, the AEF3500 – formerly known as the CJ-2000 – was first unveiled at the 2018 Airshow China in Zhuhai. The turbofan was pitched as a Chinese engine alternative for the Sino-Russian CRAIC CR929 widebody programme. Little is known about the status of the AEF3500, but media reports suggest it could be put into service on the CR929 by around 2030. Similarly to the C919, the CR929 could enter service in 2025 powered by western engines, before a Chinese-made option is offered a few years later.

It could, however, face competition from Russia in the form of Aviadvigatel's PD-35-1. In January last year, United Engine and Aviadvigatel were picked by Moscow to develop the demonstrator powerplant.

While AECC continues with work on the two engine types, the aircraft they were supposed to power are moving on with development. It remains to be seen if China can strike a double win with domestically manufactured engines on a home-grown aircraft. ■

Airbus/Boeing order backlog by engine manufacturer



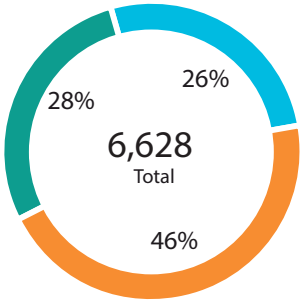
Source: Cirium fleets data (September 2019)

CFM International | Pratt & Whitney | Rolls-Royce
GE Aviation | International Aero Engines | Unannounced

2021

Projected service-entry date for CJ-1000AX

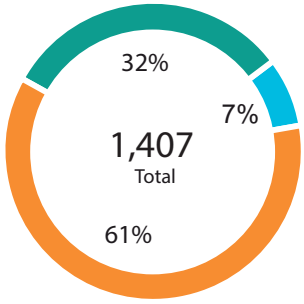
Airbus A320neo family orders by engine manufacturer



Source: Cirium fleets data (September 2019)

CFM International	Pratt & Whitney	Unannounced
3,012	1,862	1,754

Boeing 787 orders by engine manufacturer



Source: Cirium fleets data (September 2019)

GE Aviation	Rolls-Royce	Unannounced
856	446	105

400

SaM146 deliveries to Superjet since 2010

Russia

DAVID KAMINSKI-MORROW LONDON

Russia's most significant civil aircraft engine programme centres on the Aviadvigatel PD-14, which is set to be fitted for the first time to the Irkut MC-21 twinjet. Three flight-test examples of the MC-21-300 have been produced while a fourth has been assembled, says Irkut, and is now undergoing systems fitting. All four are powered by Pratt & Whitney PW1400Gs.

But Irkut is intending to offer the PD-14 as an option for the aircraft. It disclosed earlier this year that it would modify the first serial-production MC-21 for flight tests with the PD-14. The powerplant obtained Russian certification from regulator Rosaviatsia in mid-October 2018, after airborne tests on an Ilyushin Il-76, and efforts are under way to secure validation from the European Union Aviation Safety Agency.

Named for its 30,800lb (137kN)-thrust capability, the PD-14 features a three-stage low-pressure compressor and an eight-stage high-pressure compressor, linked to a two-stage high-pressure turbine and six-stage low-pressure turbine. Mock-ups of the powerplant shown during the MAKS Moscow air show in August featured composite nacelle assemblies, hollow titanium blades and other technologies. Twenty new materials, such as monocrystalline alloys were developed for the PD-14, according to state materials research institute VIAM.

No first flight date has been fixed for the PD-14-powered MC-21. But domestic engine production for the type – as well as production of the aircraft itself – has become an important issue in the wake of US materials sanctions. Russian deputy prime minister Yury Borisov pointed out earlier this year that, if necessary, the manufacturers would be "ready to switch only to domestic engines". The PD-14 is intended to be part of a family that would extend to the high-thrust PD-35, potentially for the CRAIC CR929, and projects including a possible Il-96 modernisation. Proposed lower-thrust versions include the PD-10, aimed at powering a "Russified" version of the Sukhoi Superjet 100, which is currently equipped exclusively with the Franco-Russian PowerJet SaM146.

The 15-year-old joint venture recently reached 400 engine deliveries for the Superjet programme since the first in August 2010. Total operating time for the powerplant exceeds 1.3 million hours, says the manufacturer, with one "flagship" example on a Yakutia Superjet reaching over 9,600h.

PowerJet has worked to expand customer support for the engine, with creation of special pools of spare engines and components and the extension of repair capacity in Russia and France. "More than 20 engines can be [accommodated for] repair simultaneously," it says.

Sukhoi Civil Aircraft says the total number of Superjets delivered by the end of June this year reached 162 aircraft. ■



'Russified' version of SSJ100 could be powered by a proposed PD-10 unit

Toms Kalnins/EPA-EFE/Shutterstock

Made in Korea



Twin-engined KF-X fighter could make flight debut in 2022

Korea Aerospace Industries

While KAI's aspiration to develop a home-grown advanced combat jet is progressing, the complexities of its AESA radar and Indonesia's contribution remain significant challenges

JEFF SUNG SEOUL

South Korea's ambitious plans to develop an indigenous fighter continue apace, with the stage set for production of a prototype to begin by 2021.

"The KF-X development is running smoothly on time, and the critical design reviews of the aircraft and radar systems are key milestones to produce the prototype of the KF-X jet," says Korea Aerospace Industries (KAI), the prime contractor for the 4.5-generation fighter aircraft project.

At the time of writing, the Defense Acquisition Program Administration (DAPA) was set to achieve the critical design review of the KF-X aircraft in September, following the review of the homegrown active electronically scanned array (AESA) radar system in May.

The $7.2 billion KF-X project is led by the Agency for Defense Development (ADD) and KAI in partnership with Indonesia. The aim is to produce a fighter on par with the most advanced variants of the Lockheed Martin F-16 by 2026, with a first flight planned for 2022.

At least 120 examples are expected to replace the Republic of Korea Air Force's fleet of ageing McDonnell Douglas F-4D/E Phantom IIs and Northrop F-5E/F Tiger IIs. Indonesia appears likely to obtain 48 examples of the IF-X variant, with an initial order of 16, and 32 to follow, depending on finances. This is somewhat below the 80 examples spoken of in previous years.

PRODUCTION START

The preliminary design of the KF-X was finished in June 2018, after windtunnel tests and computational fluid dynamic analysis. Production of the aircraft's bulkhead started in February 2019. Lockheed has also played a role in its development, as part of offsets related to Seoul's acquisition of 40 F-35As.

Photographs revealed of the preliminary design – codenamed C-109 – show the aircraft armed with European missiles, mainly owing to export restrictions on weapons from the USA.

Four MBDA Meteor long-range air-to-air missiles can be seen under the fuselage, with two IRIS-T short-range Diehl Defence air-to-air missiles mounted on the jet's wingtips.

DAPA originally preferred arming the KF-X with US weapons systems including Raytheon-built AIM-120 and AIM-9 Sidewinder missiles, but the US government has yet to approve export licences for these systems.

For air-to-ground operations, the jet is expected to be fitted with Taurus Systems KEPD 350E missiles with a range of 270nm (500km). These could be replaced by locally-built long-range air-to-ground missiles after LIG Nex1, a local manufacturer of precision guided missiles, was chosen in January as preferred bidder for exploratory development of the long-range

air-to-ground missile for the KF-X. This weapon will be developed by the late 2020s, with deployment possible in the mid-2030s.

In a first for South Korea, the KF-X is employing incremental arms development procedures, with the jet to be developed in two versions, an initial Block I configuration and a subsequent and Block II configuration.

The aircraft will be powered by two GE Aviation F414 engines, which also power the Boeing F/A-18E/F Super Hornet and Saab Gripen E aircraft.

UPGRADE

"The F414-GE-400-powered KF-X will deliver significantly greater mission capability, extended combat radius and longer lifespan compared to current aircraft," GE Aviation says. "The prototype engine is set to be rolled out in the first half of 2020."

Much attention has been given to the development of a home-grown AESA radar system, which industry officials and experts see as key to the success of the KF-X programme. Owing to US export restrictions, it will be developed locally by Hanwha Systems.

On 30 May, the DAPA announced the critical design review of the indigenous AESA radar had been completed and the first production prototype is set to be unveiled in the second half of 2020.

Hanhwa will produce the prototype with technical assistance from Israel's Elta Systems. Under a contract with the ADD, Elta is responsible for verifying airborne tests evaluating the South Korean AESA system.

In April, airborne tests of the KF-X's AESA hardware systems, including the transmit-receive antenna and the power supply unit, took place in South Africa with the attendance of KF-X developers from the ADD, Hanwha and KAI.

"The KF-X mock-up radar was tested on board a leased 737-500 airplane, and the tests were successful," said Lee Seung-keun, an ADD researcher involved in the KF-X AESA development during an airworthiness seminar in April. "The radar is to be further tested in Korea with the follow-up [flight tests] focused on software for multi-missions."

The radar is scheduled to be tested on board an actual KF-X prototype aircraft in 2023 with the aim of completing all aspects of development by 2026.

The KF-X AESA is based on gallium nitride technology and aims for performance similar to the Northrop Grumman APG-83 Scalable Agile Beam Radar that equips the F-16V, the ADD says. The radar will have slightly more than 1,000 transmit-receive antenna modules, with a beam-steering angle of 60-70°.

Nonetheless, concerns and questions remain about the indigenous AESA development effort, including its integration. One issue is that the ADD has multiple contracts with both local and foreign defence manufacturers related to developing the radar.

Locally, it is working with both Hanwha and LIG Nex1. Hanwha is in charge of developing the AESA hardware, but LIG Nex1 is leading the equally crucial software development.

> **"There are risks down the road, although I hope the radar project will be successful in the end"**
>
> Retired air force brigadier general
> KF-X adviser, DAPA

LIG Nex1 has long experience with AESA. It partnered with ADD between 2006 and 2013 on applied AESA research, and is also involved in phase I development of an AESA antenna and other equipment for air-to-air missiles, as well as radar systems for air-to-ground equipment.

For the KF-X radar, it is developing radar processing devices and software systems for air-to-air, air-to-ground, and air-to-sea modes – a process that started in 2017 and that will run until 2021.



Jeon Heon-Kyun/EPA/Shutterstock

South Korea's KF-X aircraft are set to replace the nation's ageing F-4D/E Phantom IIs

Saab is assisting LIG Nex1 with AESA software. Under a contract with the ADD, the Swedish aerospace firm is helping to evaluate the radar's algorithm.

On the hardware side, Hanwha is working with Leonardo, which had previously pitched its Vixen radar for the KF-X radar requirement. This co-operation falls under the auspices of a 2017 memorandum of understanding, whereby the companies have agreed to collaborate on AESA, as well as other airborne systems.

"Hanwha and Leonardo have been in talks on the development and upgrade of airborne radar systems for South Korean combat aircraft, such as the FA-50 and the KF-X," a Hanwha source says.

However, the complexity of AESA development contracts could lead to glitches at the integration stage, local experts say.

UNCERTAINTIES

"When you develop a radar, software is developed to fit in the hardware architecture," says Chang Hyung-keun, a professor at Korea Aerospace University in Goyang, Gyeonggi Province. "In that sense, it's absurd that two different companies are involved in software and hardware."

"Even if the hardware development succeeds, developing AESA software and integrating it into the hardware is a totally different story," says a retired air force brigadier general who serves as a member of DAPA's KF-X advisory group. "There are risks down the road, although I hope the radar project will be successful in the end."

Another challenge for the KF-X programme is Seoul's relationship with its only partner in the $7.2 billion programme, Jakarta. In addition to the vast technical issues facing the project, there is great uncertainty around how costs will be shared.

Despite early enthusiasm for the project, Indonesia has backtracked from its original commitment to fund about $1.4 billion – or 20% – of development costs. Citing domestic budgetary constraints, the government is seeking to renegotiate the terms of its participation.

Instead of cash, Jakarta would prefer to make payment in kind – including providing Airbus Defence & Space CN235 tactical transports produced under licence by Indonesian Aerospace, also known as PTDI, in Bandung. Whether or not South Korea will accept Indonesia's suggestion is far from clear. Wiranto, Indonesia's minister of security affairs, made the country's intention to seek a barter deal public in July.

"We are adjusting (our involvement in the KF-X/IF-X project), so, for instance, in coming stages we don't have to pay in cash but in other (forms of exchange)," the minister told Indonesia's Antara news agency. ■

Top-end trainers get set for action

Not all nations require, or can afford, latest-generation combat aircraft. This opens the door for several light attack jets on the market, including South Korea's own KAI FA-50

GREG WALDRON SINGAPORE

A modern fighter will play the starring role in any air force. With advanced sensors, powerful engines, heavy payloads and a range of capabilities, today's combat aircraft are impressive feats of engineering and a potent symbol of power. Yet this comes at significant cost – both at the acquisition stage and in terms of sustainment. So for air forces that don't have a pressing need for high-end capabilities such as aerial supremacy, deep strike or long-range standoff attacks, there is a plethora of lower-end solutions available in the form of light attack jets based on trainers.

South Korea's contribution to this market is the Korea Aerospace Industries (KAI) FA-50, which is steadily replacing legacy types such as the Northrop F-5 in service with the Republic of Korea Air Force. The FA-50 also returned the Philippines to the fast jet club when Manila ordered 12 examples in 2014 – its first jets since the retirement of its F-5s in 2004. KAI has also sold weaponised variants of the T-50, upon which the FA-50 is based to Indonesia, Iraq and Thailand. Argentina is reportedly on the verge of ordering 12.

The FA-50 is arguably in the upper end of light attack options, with supersonic capability provided by its GE Aviation F404 engine and a maximum take-off (MTOW) weight of 12,400kg (27,300lb). By comparison, the Lockheed Martin F-16V's MTOW is 21,800kg and the Saab Gripen C/D's 14,100kg. The FA-50 also packs a punch: armament includes Raytheon AIM-9 Sidewinder air-to-air missiles and AGM-65 Maverick air-to-surface missiles, and the Boeing Joint Direct Attack Munition (JDAM).

At the Paris air show in 2017, Leonardo unveiled its answer to the FA-50: an attack jet based on the M-346 advanced jet trainer, the M-346FA. Powered by two Honeywell F124s, the M-346FA has a MTOW of 10,400kg, just below that of the FA-50. As with the South Korean jet it can carry a range of ordnance including short- and medium-range air-to-air weapons, as well as precision-guided munitions.

In July, Leonardo said it had secured a launch order for six M-346FAs from a major "international customer". Subsequently, the company said that the M-346FA could achieve service entry in 2021, and that certification and integration work was ongoing. Separation tests of bombs and air-to-air missiles, including the AIM-9L, have already been performed, with integration of the Grifo fire control radar and updated avionics under way.

MARKET OPPORTUNITY

In the past both KAI and Leonardo stated that they are talking to several countries – the M-346FA is also seen as contender in Argentina. While there is a clearly a business case for the firepower and speed offered by smaller jets, views vary on the size of the market.

"It's difficult to break out [the light attack jet] market specifically, because many of the jet trainers bought today are either delivered



The FA-50 has supersonic capability and a range of armaments

Korea Aerospace Industries

with the ability to handle weapons or can be easily converted to the role," says Forecast International analyst Douglas Royce. "Over the past 30 years or so, the market for light attack versions of jet trainers has been much smaller than that of jet trainers."

He estimates that attack variants comprise around 10-15% of the overall jet trainer market. As for the advantage such aircraft offer over fighters, he says: "The primary advantage is lower acquisition and operating costs. It's much cheaper to run an armed trainer than it is to run a fighter."

FORECAST DEMAND

Leonardo forecasts a market for light attack jets of around 1,300 aircraft, excluding Russia and China, for the next 20 years. This excludes aggressor, red air and adversary air roles, for which it believes the light attack version of the M-346 is well suited.

Czech manufacturer Aero Vodochody, which produces the L-39NG – a trainer with light attack capability – as well as the L-159 attack jet, puts the market at 700 units over the next 10-15 years, excluding the US market and the US Air Force's OA-X requirement for light attack aircraft. It notes that its L-159 Alca has seen combat success with the Iraqi air force in operations against Islamic State. It adds that the type is inexpensive to acquire, operate and maintain, with the ability to operate from unpaved runways and in "extreme climate conditions". The L-159 is also operated by Draken International in the adversary role.

Offered in single- and twin-seat variants, the L-159 can carry external stores of 2,700kg, including air-to-air and air-to-ground weapons as well as targeting and electronic countermeasures pods. The company recently delivered three L-159T2 prototypes to the Czech air force. This is a twin-seat version with upgrades including new multi-function displays, night vision capability, and an improved ejection seat. Longer term, it proposes a more capable F/A-259, which will include an upgraded F124 engine.

Other trainers promoted with light attack capability include the Irkut Yak-130, the AVIC Hongdu L-15, and the AVIC Guizhou FTC-2000G. Based on the FTC-2000 trainer, the FTC-2000G has seven hardpoints and is aimed at air forces in the developing world. The variant made its public debut in the static park of Air Show China in Zhuhai in November 2018, appearing amid an impressive range of air-to-air and air-to-surface weapons such as the SD-10 semi-active air-to-air missile (the export variant of the PL-12), the CM-102 anti-radiation missile, and various guided and non-guided bombs. A promotional video from 2011 used footage from the film *Top Gun* to show the (then conceptual) FTC-2000G in air-to-air combat.

"Many of the jet trainers bought today are either delivered with the ability to handle weapons or can be easily converted to the light attack role"

Douglas Royce
Analyst, Forecast International



AVIC's Guizhou FTC-2000G had its debut at Air Show China

Greg Waldron/FlightGlobal

Other players interested in the light attack market include Textron and Hindustan Aeronautics. Although it has yet to receive orders, Textron developed the Scorpion light attack jet with its own funds. India's Hindustan Aeronautics has also promoted a combat-capable version of the Hawk 132 called Hawk-India (Hawk-i).

TOUGH COMPETITION

The sector could also receive the attention of Boeing in the form of its T-X trainer. At the Paris air show in June, Boeing vice-president Thom Breckenridge reiterated the view held by Boeing and programme partner Saab that the T-X could sell up to 2,600 units over its lifetime. This includes 1,000 examples for the US military, with the balance sold to foreign air forces. While not specifically stating light attack as a specific opportunity for the type, Breckenridge said the T-X offers development potential that would allow it to perform other missions beyond its advanced jet trainer functions.

However impressive the field of contenders, it is important to recognise that light attack jets are by no means fighters. While the arrival of the FA-50 was a pivotal development for the Philippines, for example, there are few illusions that it would help Manila wrest aerial supremacy from the Peoples' Liberation Army Air Force in any conflict over the South China Sea, where the two countries have opposing territorial claims.

The USA's OA-X requirement is in many ways a quest to find a cheap way to apply airpower in low-intensity combat zones, and Aero Vodochody also sees this as a clear market. "In the majority of current conflicts, where multirole supersonic aircraft are mainly tasked with medium-altitude precision bombing missions, this represents clear overkill. We believe that significant part of the combat mission could be downloaded to light, smart and multirole aircraft in the L-159 category."

Royce lists the many disadvantages light attack jets have compared to fighters, including the lack of capability to handle the full range of air-to-air and air-to-ground scenarios.

"They typically lack the ability to conduct [beyond visual range] combat, have inferior sensors compared to modern fighters, and carry less ordnance. And that's comparing them only to something like the Gripen or F-16. What armed trainers have going for them in the modern environment is the ability to combine a decent sensor package with precision-guided ordnance, along with a limited air-to-air capability for nations that can't afford the cost of maintaining a large fighter fleet."

This year's Seoul International Aerospace & Defense Exhibition will again offer KAI and South Korea the opportunity to promote the FA-50 to an international clientele, some of whom may feel that "real" fighters offer too much capability for practical requirements. Without specifying the size of the light attack market, KAI says it wants to attain a 30% market share. The FA-50 is by all accounts an effective aircraft, but it has its work cut out for it in a crowded market. ■



Korean army has so far received 90 KUH-1s, with 72 more in production

Korea Aerospace Industries

Surion back in business

With the fault behind last year's accident fixed, KAI is now targeting export and parapublic markets for its utility twin

JEFF SUNG SEOUL

Deliveries of the Korea Aerospace Industries (KAI) KUH-1 Surion helicopter and its variants have begun again after the fatal crash of a marine variant in July 2018. Still, there are few signs of a coveted overseas sale for the medium utility helicopter, after it lost a Philippines deal that appeared to be in reach.

Nonetheless, KAI's operating profit for the second quarter more than tripled to W93.1 billion ($76 million), the company says, mainly as a result of the resumption of the type's deliveries.

"The delivery of Surion helicopters both to the army and marine corps has been put back on track, helping to increase revenue and profits," says the company. "The sale of civil variants is also increasing steadily."

KAI has handed over 90 KUH-1s to the army, and is producing 72 more units under a third-phase contract signed in 2016. The company is scheduled to supply the army with at least 200 KUH-1s.

The company also signed a deal in 2016 to deliver 36 examples of the rotorcraft's marine version, the MUH-1 Marineon, to the marine corps by 2023. Eight medevac rotorcraft are also being delivered to the military under a 2018 contract.

A joint investigation into the July 2018 accident that killed five of the six marines on board an MUH-1 indicated defects in the French-made main rotor mast supplied by Airbus Helicopters. As a result, KAI and the Defense Acquisition Program Administration (DAPA) say the French government is now assisting in the certification of Surion parts that are imported to South Korea from Airbus Helicopters.

"The French government agreed to take part in quality certification of Surion's flight safety parts, including rotor masts and gear box, before they are delivered to Korea," says Kang Eun-ho, head of DAPA's business management bureau. "With this government-level quality certification, the flight safety and quality of parts has been improved to a great extent."

With the issue resolved, the Surion fleet resumed flights – but the accident dealt a blow to domestic sales of parapublic variants, as well as to a promising sales campaign in the Philippines, a contract that ended up going to the Sikorsky S-70i.

Still, KAI remains hopeful that the Surion will win orders from other Southeast Asian nations that have bought fixed-wing aircraft produced by KAI – such as the KT-1 basic trainer and T-50 advanced jet trainer – in the past.

"The Surion has been pitched to nations operating the KT-1 basic trainer aircraft or the variants of the T-50 supersonic trainer jet," says KAI. "As the countries have used KAI-built aircraft, we believe they have trust in our products."

SALES OPPORTUNITY

Industry sources say KAI is eyeing Indonesia as the international launch customer of the Surion, as the Southeast Asian nation has a requirement for 100 medium-lift helicopters and is a major arms trade partner with South Korea.

"The competition for the Philippines army was largely affected by the crash of the MUH-1, but we believe the Surion still has competitiveness in terms of the price and performance, as the reported defects and problems have been cleared," a KAI official involved in the export of helicopters tells FlightGlobal.

Domestically, sales opportunities are improving, with a local report in June 2019 indicating that the army would commit to as many as 130 more KUH-1s in addition to the 200 units it already has on order.

A senior KAI source tells FlightGlobal that the decision to produce more KUH-1s is partly informed by a desire to sustain the domestic aircraft industry. The plan is also in line with the army's intention to turn its frontline infantry units into an air assault force, equipped with multirole utility helicopters.

"Parties concerned are on the same page – that more Surions should be deployed in the field from the perspective of industry and force transformation," the source says. "But it



Marine variant's fatal crash in 2018 was traced to a main rotor mast defect

Korea Aerospace Industries

will still be a long process to produce more Surions. If it proceeds, the number could be adjusted depending on the budget situation."

On the civilian helicopter front, KAI hopes to get more parapublic variants into the domestic market.

In November 2018, KAI signed a new contract to supply one more maritime patrol derivative to the Korea Coast Guard, which bought two Surion-based helicopters for maritime patrol and rescue missions in 2016.

"With the proven performance and advantages of local logistic support, Surion derivatives for parapublic missions are expected to get more orders in the coming years in the local public helicopter market," KAI says.

> **"We believe the Surion still has competitiveness in terms of the price and performance, as the reported defects and problems have been cleared"**
>
> Korea Aerospace Industries

KAI has developed derivatives for police patrol, fire-fighting, mountain rescue, and maritime search and rescue. The parapublic variants are fitted with specific equipment to meet the requirements of each service, such as an electro-optical/infrared camera for the police; an integrated avionics suite and search radar for the coast guard; a water tank and an emergency medical services kit for firefighting; and a three-dimensional electronic terrain map for the forest service.

The Korea National Police Agency has ordered eight "Chamsuri" variants for airborne law enforcement and various other missions including medical evacuation and search and rescue. The Korea Forest Service has ordered one, and the Fire Safety Headquarters of Jeju Special Self-Governing Province has also acquired a single example.

KAI is planning to add another derivative for air medical services. South Gyeongsang Province, KAI's home province, has announced it is intending to acquire an air ambulance from KAI by 2021 and, highlighting its ability to carry out so-called "Dr Helicopter" modifications, the company delivered an air ambulance based on the Airbus Helicopters H225 to Gyeonggi Province in late August.

This H225-based air ambulance will be replaced when the development of the Surion air ambulance is completed, says KAI.

"The air ambulance is a new derivative of the KUH-1 and it's a symbolic product. The Korean utility helicopter will also be an effective platform to save the lives of people. We hope a formal contract will be signed soon for the first Surion Dr Helicopter," the company says.

Despite KAI's efforts to expand its domestic footprint, the local parapublic helicopter market is still dominated by foreign rotorcraft manufacturers. About 100 helicopters are operated for public services – and nine out of 10 of them were imported from overseas. Airbus Helicopters has the largest portion of the Korean parapublic rotorcraft market, followed by helicopters built by Bell, Kamov, Leonardo, and Sikorsky.

REPLACEMENT MARKET

KAI expects nearly 60 of these parapublic helicopters will need to be replaced over the next five to six years, giving KAI the opportunity to win sales with its Surion variants.

"KAI aims to sell about 400 Surion derivatives both in the military and civil markets by 2025, with the export of 300 helicopters in the global market," the company says.

Some public services, however, have raised questions about the safety of the Surion, which only has airworthiness certification for military purposes.

In 2017, the Seoul Metropolitan Fire & Disaster Headquarters selected the Leonardo Helicopters AW189 over the Surion, citing the lack of an airworthiness certificate for civil operations.

Leonardo also won a contract last July to supply the AW139 to Jeonnam Fire Service, which selected the type over a Surion derivative. Leonardo has clinched five of nine contracts to supply fire-fighting and rescue helicopters to fire-fighting services across South Korea since 2013, with Airbus Helicopters supplying three and KAI delivering one.

KAI hopes a new light helicopter programme, which will have both military and civilian airworthiness certificates, will help increase domestic sales.

"To meet the requirements for public helicopters, the Light Civil Helicopter (LCH), being developed in conjunction with the Light Armed Helicopter (LAH), would be an effective platform to expand the civil and parapublic market," says KAI.

Under a 2015 deal valued at $1.4 billion, the 4.5t LCH is expected to be ready by 2021, with the LAH to be available from 2023.

The lightweight helicopter is based on the Airbus H155, a wide-cabin derivative of the 1970s-era AS365 Dauphin. KAI aims to produce 400 units for the local market and 600 more for export.

The LCH prototype carried out its first flight in July 2018, while the maiden flight of the LAH prototype was made this year. KAI expects to build approximately 200 LAHs to replace Bell AH-1 Cobras and older MD Helicopters MD500s flown by the army. ■

FlightGlobal

110 years of aviation coverage

Throughout 110 years of continuous aviation coverage from *Flight International*, its readers have been there and read it all:

- The first international airline flight in 1919
- First ever flight of a jet airliner, the Comet, in 1949
- Man's first footsteps on the moon, and Concorde's first flight in 1969
- The formation of Airbus and Embraer in 1969
- The first flights of Boeing 777 and Eurofighter in 1994
- The first flights of the Airbus A400M and Boeing 787 Dreamliner in 2009

What will tomorrow bring?
You can keep up with all the latest stories, analysis and insight into today's aviation industry with *Flight International*.



SAVE 30% ON YOUR READERSHIP

Subscribe now and save 30% off your next one year subscription.

flightglobal.com/110fn

From yuckspeak to tales of yore, send your offcuts to murdo.morrison@flightglobal.com

Meyers 200 to live twice?

The Meyers 200 was a sturdy, speedy, single-engined aircraft of the 1950s and 1960s with a loyal following, but perhaps most famous for featuring in the James Bond movie *You Only Live Twice*, where Sean Connery is strapped to the back seat as the villainess sets the aircraft on fire before bailing out (spoiler alert: 007 manages to land the smoking, spiralling aircraft before it incinerates).

The four-seater has been out of production for 51 years but current owner Interceptor Aviation is offering for sale, through AvStrategies, the Meyers 200's manufacturing and certification assets.

Drawings, jigs and tooling have been stored – almost like an Ian Fleming plot – in a salt mine near Wichita for preservation. The sale includes the parts of a Meyers 200, along with an example of its short-lived successor, the pressurised turboprop Interceptor I-400.

Details at avstrategies.com



Interceptor Aviation

"You will never find the assets for this aircraft, Mr Bond"

Crying out loud

Few aspects of air travel polarise passengers so diametrically as the prospect of having to endure the presence of infants who are not bound by ICAO Chapter 4 noise compliance.

Preachers of tolerance like to remind travellers that they, too, were once irritable babes-in-arms and that parents of same tend to feel highly embarrassed if, despite their frantic efforts, their little ones simply won't shush. What do you think noise-cancelling headphones are for?

None of which appeases the opposition – the anxious, glaring, sleep-deprived, or just plain ragged-edge frazzled passengers – to whom the squalling is like the wail of an economy-class banshee.

This is why Japan Airlines is trying to broker a truce by displaying, on the seat-selection screen for flights, an icon letting other passengers know that a nearby seat might be occupied by a child under two years old.

Not only does this give fair warning to those who would gladly put kids in the overhead lockers, it means hassled mothers and fathers are less likely to be additionally burdened by local tutting.

It's far from a perfect solution, of course. "Child icons may not be displayed correctly if there is a change in aircraft," cautions the airline.

Until the day that hush-kits are invented for groutchy youngsters, the old methods are probably the best. You could suggest pouring a small shot of whisky into a milk bottle for a grizzling neighbour. Failing that, pour the rest into a big glass, and drink yourself unconscious.

Spooklands

Any British reader keen to escape all things Brexit might want to head for Brooklands Museum's after-dark tour, scheduled for Hallowe'en. The 31 October event promises to reveal "the darker side of the museum and unearth some of its eerie past by torchlight". Details on the museum's website.



James Veysey/Shutterstock

Cummings: aviation's loss

Dom's Rexit

Talking of Brexit, can anyone shed light on a brief episode in the career of Dominic Cummings – architect of the Leave campaign and now Rasputin-like adviser to Prime Minister Boris Johnson?

In the mid-1990s, a youthful Cummings moved to post-Soviet Russia as part of a venture that aimed to launch an airline connecting the southern Russian city of Samara with Vienna. According to his Wikipedia entry, however, the nascent carrier "fell foul of the KGB and was abandoned after only one flight".

Just think – had events turned out more kindly in the Yeltsin era, Cummings might have become an O'Leary-like icon of the aviation industry, and Brexit might have remained a Eurosceptic pipedream.

That's a W.R.A.F.

100 YEARS AGO

An Order has been issued for the final disbandment of the Women's Royal Air Force, which has already been reduced to small proportions through rapid demobilisation during the past few months. The new Order will be completed by November 8.

Russian hospitality

75 YEARS AGO

The flight of the Lancasters on a journey of 1,750 miles to the Russian base was a record for length with their load. Another agreeable feature of the adventure was the warmth of the welcome given by the Russians to the British during their stay.

The vertical future

50 YEARS AGO

If vertical take-off airliners are in production by 1980, and there is no reason why they should not be, the picture changes. If the problems of finding suitable city-centre landing sites and of noise are solved, a whole range of journeys become quicker.

Effect of eruption

25 YEARS AGO

Aviation in Papua New Guinea has been seriously curtailed as the ash cloud from Rabaul's erupting volcanoes spreads through the region. Two Cessna 402s, a Pilatus Britten-Norman Islander, a Beech Baron, a Cessna 206, an Aerospatiale Squirrel and Bell JetRanger helicopter were destroyed.

100-YEAR ARCHIVE
Every issue of *Flight* from 1909 onwards can be viewed online at flightglobal.com/archive

FLIGHT INTERNATIONAL

We welcome your letters on any aspect of the aerospace industry. Please write to:
The Editor, Flight International,
1st Floor, Chancery House,
St Nicholas Way, Sutton,
Surrey, SM1 1JB, UK
Or email:
flight.international@flightglobal.com
The opinions on this page do not necessarily represent those of the editor. Letters without a full postal address supplied may not be published. Letters may also be published on flightglobal.com and must be no longer than 250 words.

It's better late than never

I have been reading for some time the continued concerns of Emirates president Tim Clark regarding aircraft delivery delays and aircraft reliability.

His is not the only airline having problems with deliveries and reliability. Look at Air New Zealand. Half of the carrier's small fleet of Boeing 787-9s has been out with engine problems at times; it has deferred deliveries of four Airbus A320neo-family aircraft, and the airline's profits are down. Air New Zealand has just got on with it.

Tim Clark can't have it his way all the time; safety must come first. The manufacturers of aircraft and engines have very ambitious plans for their delivery schedules and development programmes, which cannot always be met.

So stop complaining and leave it to the guys who know. Airbus, Boeing and all manufacturers are trying to deliver safe aircraft with reliable engines.

Safety and proven reliability must come first. There is no compromise.

It's better late than never.

Peter Clark
Tauranga, New Zealand

LIQUIDATION

Lessons must be learned

So the Thomas Cook Group has had its wings clipped.

Responsibility for the collapse of the leisure firm on 23 September must surely lie with the directors.

How long were they aware that the company was in trouble, and that were problems looming?



Mark Thomas/Shutterstock

Human cost of firm's collapse is huge

The UK government must thoroughly investigate Thomas Cook's collapse, and lessons must be learned; after all, the human cost of this debacle is huge.

Loyal Thomas Cook employees have found themselves jobless, through no fault of their own, and thousands of customers have had their holidays ruined or cancelled.

Stephen Ryder
Cambridge, UK

FlightJobs



Take your career to new levels

Register your CV and start your job search today

Get premium content every week, including top tips, careers advice and industry developments

Set up job alerts and receive relevant jobs in your inbox as soon as they appear

Create your profile and get headhunted by recruiters and airlines

Start your journey today. Register at Jobs.flightglobal.com/register

@flightjob @flightglobaljobs FlightJobs

EDITORIAL, ADVERTISING, PRODUCTION & READER CONTACTS

EDITORIAL
1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB, UK
flight.international@flightglobal.com

Editor Craig Hoyle
+44 20 8652 3834
craig.hoyle@flightglobal.com
Deputy Editor Dominic Perry
+44 20 8652 3206
dominic.perry@flightglobal.com
Head of Strategic Content Murdo Morrison FRAeS
+44 20 8652 4395
murdo.morrison@flightglobal.com
Features Editor Dan Thisdell
+44 20 8652 4491
dan.thisdell@flightglobal.com
Business & General Aviation Editor Kate Sarsfield
+44 20 8652 3885
kate.sarsfield@flightglobal.com
Consulting Editor David Learmount
+44 7785 901787 david.learmount@ntlworld.com
Magazine Enquiries
flight.international@flightglobal.com

AIR TRANSPORT TEAM
Executive Editor Graham Dunn
+44 20 8322 6858
graham.dunn@flightglobal.com
Managing Editor – Airline Business Lewis Harper
+44 20 7911 3105
lewis.harper@flightglobal.com
Air Transport Editor David Kaminski-Morrow
+44 20 8652 3909
david.kaminski-morrow@flightglobal.com

AMERICAS
Americas Air Transport Editor Pilar Wolfsteller
+1 510 634 3496
pilar.wolfsteller@flightglobal.com
Americas Aerospace Editor Jon Hemmerdinger
+1 617 397 2809
jon.hemmerdinger@flightglobal.com
Aviation Reporter Garrett Reim
+1 571 216 5327
garrett.reim@flightglobal.com

ASIA/PACIFIC
Asia Editor Greg Waldron
+65 6780 4314
greg.waldron@flightglobal.com
Reporter Alfred Chua
+65 6780 4309
alfred.chua@flightglobal.com

CIRIUM DASHBOARD EDITORIAL
Steve Goldstein, Michael Gubisch, Firdaus Hashim, SiMin Ngai, Niall O'Keeffe, Thomas Risen, Jonathan Robins, Sophie Segal, Ellis Taylor

FLIGHTGLOBAL.COM
Online Content Manager Amber Elias
+44 20 8652 3835
amber.elias@flightglobal.com

EDITORIAL PRODUCTION
Chief Copy Editor, FlightGlobal Dan Bloch
Layout Copy Editor Tim Norman
Deputy Global Production Editor Rachel Warner
Deputy Global Digital Producer Andrew Costerton
Consulting Technical Artist Tim Hall

DISPLAY ADVERTISEMENT SALES
1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB, UK

EUROPE
Key Account Manager Richard Perry
+44 20 8652 8798
richard.perry@flightglobal.com
Sales Support Gillian Cumming
+44 20 8652 8837

NORTH & SOUTH AMERICA
Vice-President, North & South America Rob Hancock
+1 703 795 5155
robert.hancock@flightglobal.com
Regional Sales Director Warren McEwan
+1 703 836 3719
warren.mcewan@flightglobal.com

ITALY
Sales Manager Riccardo Laureri
+39 (02) 236 2500
media@laureriassociates.it
Laureri Associates SRL, Via Vallazze 43,
20131 Milano, Italy

ISRAEL
Sales Executive Asa Talbar
+972 77 562 1900
Fax: +972 77 562 1903
talbar@talbar.co.il
Talbar Media, 41 HaGiva'a St,
PO Box 3184, Givat Ada 37808, Israel

ASIA/AUSTRALASIA
Key Account Manager Jay Ee
+65 9173 3502
jay.ee@flightglobal.com
DVV Media International (Asia) Pte. Ltd.
15 Beach Road, 2nd Floor,
Singapore 189677

RUSSIA & CIS
Director Arkady Komarov
Tel/Fax: +7 (495) 987 3800
komarov@worldbusinessmedia.ru
World Business Media,
Leningradsky Prospekt, 80,
Korpus G, Office 807,
Moscow 125190, Russia

RECRUITMENT
Head of Sales Sophie Wild
+44 20 8652 4239
sophie.wild@flightglobal.com
Business Development Manager Katie Mann
+44 20 8652 3074
katie.mann@flightglobal.com
Business Development Manager Lauren Cooper
+44 20 8652 4985
lauren.cooper@DVVmediainternational.com

CLASSIFIED
Key Account Manager Jay Ee
+65 9173 3502
jay.ee@flightglobal.com

ADVERTISEMENT PRODUCTION
Production Manager Sean Behan
+44 20 8652 8232

MARKETING
Group Marketing Manager Jo Goodwin
+44 20 7911 1366
jo.goodwin@flightglobal.com

DATA
Data cited in Flight International is sourced from Cirium, a data and analytics company in the wider travel industry. For Cirium's data team, please contact: Trevor Mountford
trevor.mountford@flightglobal.com

PUBLISHING MANAGEMENT
Managing Director Andy Salter
VP, FG Connect and Conferences Mark Pilling
mark.pilling@flightglobal.com
Executive Director Content Max Kingsley-Jones
max.kingsley.jones@flightglobal.com
Commercial Director Publishing Stuart Burgess
stuart.burgess@flightglobal.com

READER SERVICES
Subscriptions
Jenny Smith
Flight International
Subscriptions, DVV Media International,
PO Box 302, Haywards Heath,
West Sussex, RH16 3DH, UK

Subscription Enquiries
From UK: 0330 333 9533
From overseas: +44 1444 475 682
Fax +44 1444 445301
flightinternational.subs@quadrantsubs.com

Subscription Rates
1 Year: £145/$229/€179
2 Years: £246/$389/€304
3 Years: £348/$549/€429
Only paid subscriptions available. Cheques payable to Flight International

Flight International is one of FlightGlobal's (publishing, events and FlightJobs) products and services.

FlightGlobal uses data and analytics sourced from Cirium.
www.cirium.com

Flight International welcomes unsolicited contributions from readers but cannot guarantee to return photographs safely.

© and Database Rights 2019 DVV Media International Ltd. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission in writing of the publishers.

Registered at the Post Office as a newspaper. Published by DVV Media International Ltd, 1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB, UK.

Newstrade distributed by Marketforce (UK), 2nd Floor, 5 Churchill Place, Canary Wharf, London, E14 5HU, UK. Tel: +44 20 3787 9001.

Classified advertising prepress by CCM. Printed in Great Britain by William Gibbons and Sons Ltd

Flight International published weekly 49 issues per year.

This periodical is sold subject to the following conditions: namely that it is not, without the written consent of the publishers first given, lent, re-sold, hired out or in any unauthorised cover by way of trade, or affixed to, or as part of, any publication of advertising, literary or pictorial matter whatsoever. No part of the content may be stored electronically, or reproduced or transmitted in any form without the written permission of the Publisher.

ISSN 0015-3710 (Print) ISSN 2059-3864 (Online)

DVV Media International

recycle
When you have finished with this magazine please recycle it.

EVENTS

5-7 November
Vertical Flight Expo
Farnborough, UK
verticalflightexpo.com

17-21 November
Dubai Air Show
Dubai, UAE
dubaiairshow.aero

4-5 December
Mexico's Aerospace Summit
Santiago de Queretaro, Mexico
mexicoaerospacesummit.com

5-6 December
Aerospace Big Data
Barcelona
Barcelona, Spain
flightglobal.com/bigdata

10-12 December
Gulf Defense & Aerospace
Kuwait City, Kuwait
gulfdefense.com

28-30 January 2020
HAI Heli-Expo
Anaheim, California, USA
rotor.org/home/heli-expo

4-6 February
Routes Americas
Indianapolis, Indiana, USA
routesonline.com

11-16 February
Singapore Air Show
Singapore
singaporeairshow.com

25-28 February
Aerospace Europe Conference
Bordeaux, France
ceas.org/aerospaceeurope2020

30 March-4 April
Global Aerospace Summit
Abu Dhabi, UAE
aerospacesummit.com

31 March-5 April
FIDAE International Air & Space
Santiago, Chile
fidae.cl

22-26 April
Eurasia Air Show
Antalya, Turkey
eurasiaairshow.com

2-3 May
Wings over Illawarra
Wollongong NSW, Australia
www.wingsoverillawarra.com.au

13-17 May
ILA Berlin Air Show
Berlin, Germany
ila-berlin.de

17-19 July
Royal International Air Tattoo
RAF Fairford, Gloucestershire, UK
airtattoo.com

20-24 July
Farnborough International Air Show
Farnborough, UK
farnboroughairshow.com

For a full list of events see **flightglobal.com/events**

FlightClassified

Calls may be monitored for training purposes

TEL +44 (0) 20 8652 8130 **EMAIL** Jay.Ee@flightglobal.com

New and used aircraft

SkyWorld Aviation

The Regional Aircraft Marketing Specialist
Tel. + 44 1753 832088 juliet@skyworld.co.uk

For sale

Fleet of Avro RJ aircraft and associated spares and tooling



- 2 x RJ85s
- 8 x RJ100s
- Available 4Q19/1Q20

www.skyworld.co.uk

Equipment, maintenance and service

mt-propeller


Cessna 441 with 5-blade MTV-27 Propeller

Airport Straubing-Wallmuehle, EDMS
94348 Atting / Germany
Phone:+49(0)9429-9409-0
Fax: +49(0)9429-8432
sales@mt-propeller.com
www.mt-propeller.com

Development & Production of high performance composite constant speed propellers.

FLY GREEN - FLY MT

Sales & Service for products made by McCauley, Hartzell, Sensenich, Woodward, Goodrich.

Business services







CLASSIFIED
TEL +44 (0) 20 8652 8130 EMAIL Jay.Ee@flightglobal.com

Courses and tuition



UK Civil Aviation Authority International

Airworthiness courses by the UK CAA

London Gatwick

EASA Part 145 Maintenance Organisation Approval

Delegates will explore the Part 145 Maintenance Approval principles, and how to determine corporate and individual responsibility to ensure your organisation meets the requirements. This course is suitable for operators and maintenance organisations, regulatory staff from National Aviation Authorities and Maintenance, Repair and Overhaul approval holder. 21 - 22 Nov 2019 I London Gatwick

EASA Part G Production Organisation Approval

Provides an overview of EASA Part 21 Subpart G and associated Acceptable Means of Compliance and Guidance Material. Delegates will also receive instruction on how to construct a Production organisation Exposition. This course is suitable for individuals responsible for compliance or certification within a production organisation.
4 - 5 Dec 2019 I London Gatwick

To book now or for more information, please visit
www.caainternational.com/training or contact us:
E: training@caainternational.com T: +44 (0)330 0224401

www.caainternational.com
Part of the UK CAA International Group

Together for better aviation

Essential Courses for all CRM Trainers

CRMT

CRMT Course

The CRM Trainers course is for participants who will deliver CRM training for pilots and cabin crew of airlines and other aviation operations. It meets the requirements of EASA, FAA and all major regulatory bodies. 5-day CRMT courses 2 Sep, 7 Oct, 4 Nov, 2 Dec at Global Air Training.

Cabin CRMT

A CRM Trainers course with specific focus on delivering CRM training for airline cabin crew. 5-day courses 2 Sep, 7 Oct, 4 Nov, 2 Dec at Global Air Training.

CRMT Refresher

The CRMT refresher course meets the EASA requirement for CRMT to attend a refresher course every 3 years.
1-day courses 14 Oct, 9 Dec.

CRM Human Performance

EASA regulations require all CRM trainers to complete a HPL course.
2-day courses 31 Oct, 30 Jan.

More info & book online:
www.globalairtraining.com

t: +44 (0)1829 771334
e: ops@globalairtraining.com

GLOBAL Air Training

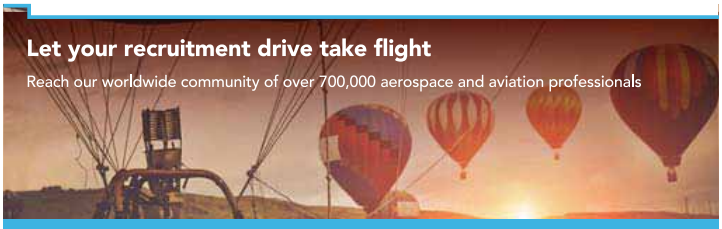
Tenders

Airline Allied Services Limited
(A wholly owned subsidiary of Air India Limited)

NOTICE INVITING TENDER

Name of the Tender	**Tender for Dry Lease of Two (02) New ATR 72-600 aircraft in Alliance Air**
Tender Reference Number	**AASL/ATR 72-600/TENDER-2019/416**
Tender Date	20 September 2019
Tender Closing Date	21 October 2019 by 1430 hours IST.
Technical Bids Opening Date	21 October 2019 by 1430 hours IST.
Availability of Tender Document	The Tender can be downloaded from website (www.airindia.in)

FlightJobs



Start attracting the right talent. Speak to the experienced Flight Jobs team about our bespoke recruitment solutions.
flightglobal.com/jobs +44 (0)208 652 4900

FSM

Professional Flight Assessment Training



Assessment coming up? Need some practice?

FSM Professional Flight Training provide low cost simulator training on B737, B747 & Airbus A320

For more info please get in touch:
Captain Chris Rigby - info@flyfsm.co.uk
www.fsmprofessionalflighttraining.co.uk
tel 0800 999 7370

B747- 400 CAPTAIN

MIDDLE EAST - GULF AREA

A VVIP Operator is looking for an enthusiastic, adaptable and motivated Captain for their B747-400 operations. The Operator offers excellent career opportunities for the right candidate. The ideal applicants will meet the following criteria:

- Current on B747- 400 and B747-8
- Holding Class 1 Medical Certificate
- ICAO English Proficiency level 4 or above
- 7000 flying hours of which no less than 2500 on multi-engine turbojet transport aircraft and no less than 2000 hours must be in command on B747- 400

Please forward your CV with a breakdown of your flying experience into PIC and non-PIC hours by aircraft type, together with copies of licenses, relevant professional certificates, passport copy, passport sized photograph and references from previous employers to the address below.

FLIGHT SAFETY SPECIALIST

MIDDLE EAST - GULF AREA

A prestigious VVIP Operator is looking for an enthusiastic Flight Safety Specialist to join its growing team.

The ideal applicant will be a motivated team builder with a minimum of 10 years' experience in flight safety.

In this highly visible role the candidate will have:

- Detailed knowledge and understanding of Safety Management Systems as well as the requirements to implement Safety Management Systems
- A sound background in System Safety Programs and Accident/Incident Investigations
- Completed an accredited quality system auditor-training course or have hands-on experience in aviation system auditing
- Experience in the development of Incident Reporting Systems and resultant database management and storage
- Comprehensive qualifications in safety evaluation and risk assessment
- A strong command of the English language together with a demonstrated ability to produce well-structured planning documents, briefing papers and comprehensive safety reports
- Initiative, tact, sound judgement and the ability to maintain harmonious relationships within a small multi-discipline team
- Advance computer skills
- Experience working within a diverse multi-cultural environment

This position would suit an individual who holds or has held an ATPL with TRE experience or an Aircraft Maintenance License with EASA 66 AML experience

The appointment will be for an initial two year contract renewable annually thereafter. The employment package includes a generous salary free of local tax, end of contract gratuity and married accompanied accommodation with hard furnishings and free utilities, 60 days leave per annum with free travel to country of domicile, free in-country medical facilities and associated school fees.

To apply for the above post please forward CV, covering letter, copies of relevant professional certificates, copies of licenses and a passport copy to the following address:

C/O Bernadette Griffin, Charles Kendall & Partners,
7 Albert Court, Prince Consort Road, London SW7 2BJ
Tel: + 44 (0) 207 589 1256
Fax: + 44 (0) 207 589 1836
Email: omanrecruitment@charleskendall.com

Charles Kendall



Now Hiring: Line Captains for A320



PROCTOR Aviation

Contact Us Today:
a320@proctoraviation.com
www.proctoraviation.com

SIMULATOR INSTRUCTOR OPPORTUNITIES NOW AVAILABLE IN FARNBOROUGH, UK

Join our world-class, worldwide team of close to 5,000 dedicated aviation professionals. Be part of a strong, successful company that's been providing training leadership and enhancing aviation safety since 1951. Find out why FlightSafety, a Berkshire Hathaway company, is one of the best places to work in aviation.

Are you seeking a rewarding career in aviation with a better work-life balance? We have full-time permanent Ground School/Simulator Instructor positions available with an excellent and comprehensive training program, ongoing practical support and stable rostering. These roles may be of particular interest to pilots from within Europe, who may want a break from flying or have recently retired from operations yet still have a passion for aviation.

Minimum Requirements

- Hold or have held JAA/EASA licences
- Have at least 1,500 hours as a pilot of multi-pilot aircraft
- Preference will be given to those with Gulfstream experience

A medical certificate is not required. Previous instructing experience is not required as you will benefit from our world-class training programme. Full annual salary is paid throughout training.

We provide a competitive salary, a professional and friendly working environment with an excellent benefits package.







To apply, visit careers.flightsafety.com and use the location filter for Farnborough, Ref #13218
Call +44 (0) 1252 554 500 or email recruitment.farnborough@flightsafety.com

FlightSafety international

GREAT NEWS FOR PILOTS AND OPERATORS ALIKE.



PARTNERSHIP

AVIONCO
THE BUSINESS OF FLIGHT

pilot movers

AVIONCO AND PILOT MOVERS HAVE CREATED A NEW ALLIANCE TO BRING MORE PILOTS TO MORE OPERATORS.

Register now or contact us at www.avionco.ao.gg or www.pilotmovers.com

LEADS Aviation Consultants

www.leadsaviation.com



Airlines our pilots are flying:

allegiant · American Airlines · interjet · Atlantic Armenian Airlines · Safi · British Airways · Bulgaria Air · China Eastern · Avianca · Air Busan · Frontier Airlines · Olympus Airways · LATAM · airberlin · Qatar Airways · Aer Lingus · Oman Air · Air Albania

FLIGHT CREW FUTURES

A FRESH APPROACH TO PILOT CAREER OPPORTUNITIES FOR THE EXPERIENCED PILOT

BALPA

COME AND MEET THE RECRUITERS & AIRLINES OFFERING GENUINE CAREER OPPORTUNITIES FOR EXPERIENCED PILOTS

FREE REGISTRATION

16 OCTOBER 2019

THE HILTON, LONDON GATWICK

FROM 10 AM

Spring Japan · Emirates · West Atlantic · nobox Pilot Solutions · OSM Aviation · Simtech Aviation · Goose Recruitment · millstream Global Flying · Leading Edge Aviation · SWOOP! · FTEJerez · FlightSafety International · Spectrum Aviation Personnel · Wizz

REGISTER NOW

WWW.PILOTCAREERNEWS.COM/LIVE/FLIGHTCREWFUTURE/UK-AUTUMN

FlightJobs



Take your career to new levels

Register your CV and start your job search today

Get premium content every week, including top tips, careers advice and industry developments

Set up job alerts and receive relevant jobs in your inbox as soon as they appear

Create your profile and get headhunted by recruiters and airlines

Start your journey today

Register at Jobs.flightglobal.com/register

@flightjob
@flightglobaljobs
FlightJobs

WORK EXPERIENCE MAGGIE APPLETON

Telling the RAF story in all its glory

Maggie Appleton is chief executive of the Royal Air Force Museum, a role that encompasses her vision to inspire the public about the service's activities using personal testimony and immersive exhibitions

What sparked your interest in aviation?

I came to my role at the Royal Air Force Museum through a museum curator/director route, rather than aviation – so my interest has grown through experience of museums over many years, and latterly via my relationship with the Royal Air Force. I used to bring my children to the RAF Museum and was fascinated by it as a historian and a visitor. My father was an RAF armourer during the Second World War – he died when I was young, so while this wasn't part of my upbringing, it has certainly given me an additional emotional connection to the RAF and aviation.

What was your route to the RAF Museum?

I began my museum career at the Royal Armouries in 1991, when it was still based in the Tower of London, and progressed through community museums at Stevenage and in Luton. I then broadened my scope and learned a huge amount as the chief executive of Luton Culture, the charity that runs the museums, arts, libraries and community centres in the town. My early career as assistant curator and then curator at Stevenage was an amazing apprenticeship for my current role, as I had the opportunity to be hands on right across the organisation.

What is the role of the RAF Museum?

Our vision is to inspire everyone with the RAF story – the people who shape it and its place in our lives. Our role is to share the story using the experiences of its people and our collections to engage, inspire and encourage learning. Most visitors come for a great day out, rather than because they have a specialist interest in the RAF or aviation, so we have to think carefully about how to engage them as well as our more knowledgeable and connected audiences. Clearly we have a key role too in encouraging more young people to pursue a career in aviation and in science, technology and engineering. We focus on sparking interest through our learning teams at both sites (at Cosford in the West Midlands and London) and by ensuring we represent a diverse range of people and their experiences in our displays so visitors, whatever their background, can see themselves in those roles.



Royal Air Force Museum

Last year a major upgrade marked the centenary, says Appleton

What are your responsibilities?

We are one of the UK's national museums, as well as being a charity, and my responsibility is to lead the organisation and to work with our trustees and my colleagues on the team to develop and steer a clear direction. We've just launched our strategic framework for the next 10 years, which sets an ambitious programme for both sites. Last year, we marked the centenary of the RAF with a major transformation programme of our London site. This comprised new exhibitions, landscaping to evoke our aviation heritage, new learning programmes and refurbishment of some of our historic buildings. The result was an increase in visitor numbers by almost 40% on previous years, which gives us a hugely important platform for our future.

Do you have any current highlights in the museum?

Both our museums give a wonderful welcome to visitors – through the beautiful spaces, our immersive exhibitions and our great team. The Lancaster in London is a powerful reminder of the contribution the RAF has made across its history, and our first Gulf War RAF prisoner of war suit in the Age of Uncertainty exhibition underlines the same spirit and bravery of our men and women today. At Cosford, our Cold War exhibition is phenomenal for the quality of the collection – you can't see all three V bombers together anywhere else.

Are there specific demands made by the role?

Running a museum brings the same challenges as running any business, with the added responsibility to balance income generation and financial sustainability with ensuring we focus on delivering our vision and remaining true to our values as a charity and public body. The funding climate is increasingly testing, but we have a compelling vision and are incredibly excited and positive about our plans. ■

Looking for a job in aerospace? Check out our listings online at flightglobal.com/jobs

If you would like to feature in Working Week, or you know someone who would, email your pitch to **kate.sarsfield@flightglobal.com**

FlightGlobal is now on WeChat
Follow us for more industry news and analysis in Chinese.
关注 FlightGlobal 航升 微信公众号，了解行业最新资讯和动态

Reflecting on the past. Looking to the future.

Our 600+ airline customers have helped CFM define the power of flight and these relationships have been the very heart of our business for more than four decades. Today, we have the power to redefine the future. Extraordinary together.

cfmaeroengines.com

CFM International is a 50/50 joint company between GE and Safran Aircraft Engines





Extraordinary together

cfm