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AirMaintenance UPDATE

The Magazine for Aircraft Maintenance Professionals

2016 Recurrent Training Exam

Thinner is always better: the new GE9X engine

Transport Canada Approved for R/T

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Turn of the screw

Leonardo da Vinci's late 15th century sketches of a "helical air screw" are often credited as the technical inspiration for the modern day helicopter. According to the website www.da-vinci-inventions.com, "Da Vinci's helicopter measured more than 15 feet in diameter and was made from reed, linen and wire. It was to be powered by four men standing on a central platform turning cranks to rotate the shaft. With enough rotation, da Vinci believed the invention would lift off the ground." The plan didn't work of course, but that didn't stop Leonardo from trying other things — the man was not easily discouraged. Nor was he the last garage inventor to tackle human-powered flight.

Many came after da Vinci, and likely countless others before him. But few had the success of biology student and female pilot Judith Wexler, who flew the human-powered helicopter "Gamera I" for 4.2 seconds in College Park, Maryland, thus setting the first ever world record in this type of aircraft.

Her record-breaking performance took place on May 12, 2011, which means that this year we can officially celebrate the event's fifth anniversary. The "Gamera Project" was introduced to try and achieve the dream of human-powered hovering flight. No less than 50 graduate and undergraduate students from the Alfred Gessow Rotorcraft Centre of the University of Maryland's Department of Aerospace Engineering participated in the design and construction of Gamera I. It was made of several lightweight composites and foam; the total weight of this quadrotor helicopter was just about 95.25 kg (209 pounds) including the pilot.

For such records, three factors are essential: design, weight, and power. In order to increase the altitude and time in the air, reducing the weight of the aircraft, increasing the efficiency of the rotor design and finding a pilot of just the right size and strength are critical. This immutable fact of physics was just as true when da Vinci experimented with human-powered flight as it is today with the current testing of GE's new GE9X jet engine that is fitted with fourth-gen carbon-fibre composite blades and is capable of producing a factory-spec 100,000 pounds of thrust. We've come far since da Vinci, but some things remain the same. Read about the GE9X this issue.

— John Campbell
Editor

Departments

Features

AirMaintenance Update

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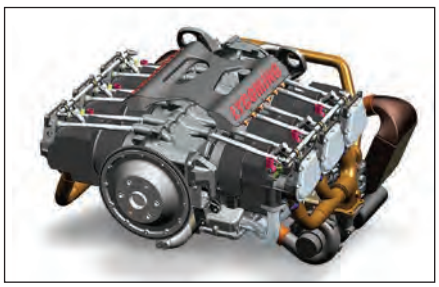
Upcoming Events

New engine debuts in Florida



Lycoming Engines has announced the first customer delivery of its Integrated Electronic Engine (iE2) on a Lancair Evolution. The new customer built piston-powered Evolution was showcased in early April at the SUN 'n' FUN International Fly In and Expo in Lakeland, Florida. Lycoming's iE2 engine is the company's flagship technology. The engine was designed from the ground up to be electronically controlled.

The Lancair iE2 configuration is designated the YTEO- 540-B1A, delivering 350 horsepower from a twin turbocharged and intercooled six cylinder arrangement. An electronically controlled propeller governor tuned to maximize engine and aircraft performance is part of the package.

"Lycoming's iE2 is an optimum fit for the piston Lancair Evolution kit, providing maximum performance while also reducing pilot workload," said Michael Kraft, senior vice president and general manager at Lycoming Engines. "The combination of Lycoming's iE2 engine technology with Lancair's Evolution airframe technology makes for a very exciting piston-powered aircraft. It's great to see this product moving out now more broadly in General Aviation applications."

CANADA

Great Lakes International Air Show
June 18 – 19, 2016
St. Thomas, Ontario
www.greatlakesinternationalairshow.ca

CBAA 2016
July 5 – 7, 2016
Calgary, Alberta; www.cbaa-acaa.ca

Northern Skies Air Show
July16 – 17, 2016
Peace River, Alberta
www.peaceregionalairshow.com

Abbotsford International Air Show
August 12-14, 2016
Abbotsford, British Columbia
www.abbotsfordairshow.com

Airshow Atlantic
August 20 – 21, 2016
Miramichi, New Brunswick
www.airshowatlantic.ca

Rotary Charity Air Show
August 31, 2016
Brantford, Ontario
www.rotarycharityairshow.ca

UNITED STATES

National BiPlane Fly-In
June 3 – 4, 2016
Junction City, Kansas
www.nationalbiplaneflyin.com

Boeing SeaFair
June 15 – August 21, 2016
Seattle, Washington
www.seafair.com

Air Show & Balloon Festival
June 29 – July 4, 2016
Battle Creek, Michigan
www.bcballoons.com

National Cherry Festival Air Show
July 2 – 9, 2016
Traverse Bay, Michigan
www.cherryfestival.org

Thunder over Michigan
August 20 – 21, 2016
Ypsilanti, Michigan
www.yankeeairmuseum.org

Airshow of the Cascades
August 26 – 27, 2016
Madras, Oregon
www.cascadeairshow.com

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STCs & new products

Strap latch design eliminates cables and pulleys

Schweiss Doors has introduced an all-strap bifold door that is said to have no cables, chains, sprockets or pulleys and overall 90 percent fewer moving parts. The polyester straps do all the latching, securing the door in open or closed positions. They are rated to a factory-spec 29,000 pounds and are intended to add protection from wind gusts while in operation.

For more information visit www.bifold.com

New seating for 737 passengers from Encore

LIFT by EnCore has announced the launch of its new Tourist Class seating for Next-Generation 737 and 737 MAX airplanes. Tourist Class Seating available in-line and retrofit is the first seat specifically designed to complement the 737 Boeing Sky interior. This product is intended to maximize passenger-seating space, and is said to be ergonomically optimized and designed for maintainability and reliability, ensuring long-term comfort. Currently in the design and certification phase, Tourist Class Seating is targeted for delivery in mid-2017.

For information visit www.encoreaerospace.com

Ergodyne introduces new line of trades gloves

Ergodyne has released its new ProFlex Trades Gloves series, which includes a mix of eight updated and six new models designed and built from two patent-pending ProFlex glove platforms: the Utility and Heavy-Duty Utility. The new models are said to offer better functionality and protection with traits like touch screen-capability, enhanced cut resistance, and improved abrasion resistance.

For information visit www.ergodyne.com

Larson's portable explosion-proof LED work light

Larson Electronics' new pedestal mount LED work light produces 12,000 lumens and illuminates up to 9,000 square feet of workspace. The explosion-proof LED light is mounted within an A-frame portable stand constructed from non-sparking aluminum and powder coated for increased durability and corrosion resistance. The product contains 12 individual boards configured in a series of banks, with each bank containing two LED boards with an individual driver.

For more information visit www.Larsonelectronics.com

The next generation line of corded grinders

Walter Surface Technologies is now selling its next generation of corded grinders, featuring eight redesigned and one new power tool, the Pro 5. The redesigned grinders feature an ergonomic anti-vibration side handle, a tool-free guard, and a safety clutch that neutralizes momentum and eliminates dangerous backlash. In this group of tools, the small angle grinders (Mini-Grinder and the Super) are designed for work in smaller metalworking and MRO shops.

For more information visit www.walter.com

Blue-glowing floor path marking system from STG Aerospace

STG Aerospace has introduced saf-Tglo blu, which is said to be the world's first blue-glowing photo-luminescent floor path marking system. Based on the original saf-Tglo photo-luminescent range, saf-Tglo blu shifts from the traditional green glow to a cool blue glow to enhance the cabin aesthetics without comprising passenger safety. Like other saf-Tglos systems, saf-Tglo blu requires no power source and is said to be fully-charged by the cabin lighting within minutes.

For more information visit www.stgaerospace.com

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- Cessna Encore & Ultra Encore
- Citation X & Sovereign
- Gulfstream G200
- Gulfstream 550
- Gulfstream G-IV
- Gulfstream G-V
- Challenger 300
- Challenger 600 Series
- Falcon 2000
- Global Express
- Learjet 45
- Hawker 800
- Falcon 50

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P&W PINS GREEN HOPES ON NEW ENGINE

On May 16, Pratt & Whitney unveiled its newest engine, which the company hopes will revolutionize green travel. Pratt & Whitney's new commercial engine, the PurePower Geared Turbofan, entered into service earlier this year, and deliver up to a claimed 75 percent reduction in noise footprint, a 50 percent overall reduction in regulated emissions, while reducing fuel consumption by 16 percent. Pratt & Whitney says the fuel savings alone will cut carbon dioxide emissions by an amount equivalent to the CO2 emissions that 900,000 trees eliminate from the air each year. The PurePower Geared Turbofan engine has been selected by five aircraft makers and has more than 7,000 orders, including options, with more than 70 customers from more than 30 countries.

CREATIVE USE OF OLD AIRCRAFT RUBBER

As worldwide tourism increases so do environmental regulations for aviation. American Airlines says it's trying to do its part by cutting waste while meeting demand. Among the company's creative efforts in this area is the recycling of aircraft tires, processing up to 26,000 of them per year for reusable rubber—resulting in 800 tons of wastewater laden with grease, hydraulic fluid, and brake dust. Instead of dumping wastewater in landfills, American Airlines has partnered with Covanta, an energy-from-waste provider, to safely eliminate contaminates in a boiler system and create steam that is used by a local refinery. *(Kalena Gravina).*

SIX BILLION GALLONS OF JET FUEL SAVED

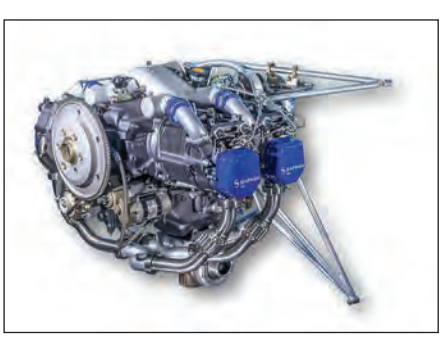
Joint venture company Aviation Partners Boeing claims that as of mid-April its Blended Winglet technology has saved the world's commercial and business jet operators an estimated six billion gallons of jet fuel, representing a global reduction in CO2 emissions of over 64 million tons. This is equivalent to the fuel used by approximately 12 million passenger cars being driven for a year. Blended Winglets are now flying on more than 7,000 jet airplanes and over 20 airplane types, including the Dassault Falcon 2000, 900 & 50 series, Hawker 800 series and Gulfstream II aircraft. By reducing drag, blended winglets increase fuel efficiency and boost range; they are additions to the airplane wing that reduce the drag caused by wingtip vortices and the twin tornados formed by the difference between the pressure on the upper surface of an airplane's wing and that on the lower surface. The blended winglets, which feature a large radius and smooth chord variation in the wing-to-winglet transition area, are said to have demonstrated more than 60 percent greater effectiveness over conventional winglets with an angular transition.

AIR CANADA FREIGHTERS FLY TO LATIN AMERICA

Air Canada and Cargojet Airways Ltd. have announced they are finalizing a commercial arrangement that will result in Air Canada Cargo introducing dedicated freighter services from Canada to Latin America and Europe with Boeing 767-300ER freighter aircraft operated by Cargojet.

Air Canada Cargo will become the only provider of direct scheduled freighter service between Canada and Latin America. The new Air Canada Cargo flights will provide 52 tonnes of net cargo capacity and were scheduled to begin June 9, subject to obtaining the necessary regulatory approvals. Initial routes include Toronto to Bogota, and to Mexico City.

DIESEL ENGINE STC PROGRAM FOR CESSNA 182



Soloy Aviation Solutions and SMA Engines have announced a second-generation Supplemental Type Certificate development program to incorporate the French engine manufacturer's latest version of its SR305-230E compression ignition aircraft engine in the Cessna 182 Skylane airframe. Applicable C182 aircraft models will be finalized as the

program gets underway. The engineering and testing program will be completed and validated at Soloy Aviation Solutions' US-based facility in Olympia, Washington under European Aviation Safety Agency regulations. Under the agreement at the program's completion, Soloy Aviation will become the STC holder of the engine conversion program and intends to market the conversion STC globally.

"At the program's completion, we expect to be able to offer a wide variety of Cessna 182 owners the chance to convert their current avgas engines to this efficient and powerful engine platform either at overhaul or anytime during TBO under the revised Soloy STC," says Soloy CEO James Cowan. Soloy and SMA will get the program underway immediately and expect to complete the program within 12 months.

FINNAIR FOUND TO BE THE LEAST POLLUTING AIRLINE

Finland's Finnair and TAP Portugal have emerged as the two least polluting carriers in a study of 20 of the world's biggest airlines. A study of greenhouse gas emissions produced by the airline industry from 2007 to 2014 revealed none are showing a significant reduction over the seven years for those that provided data.

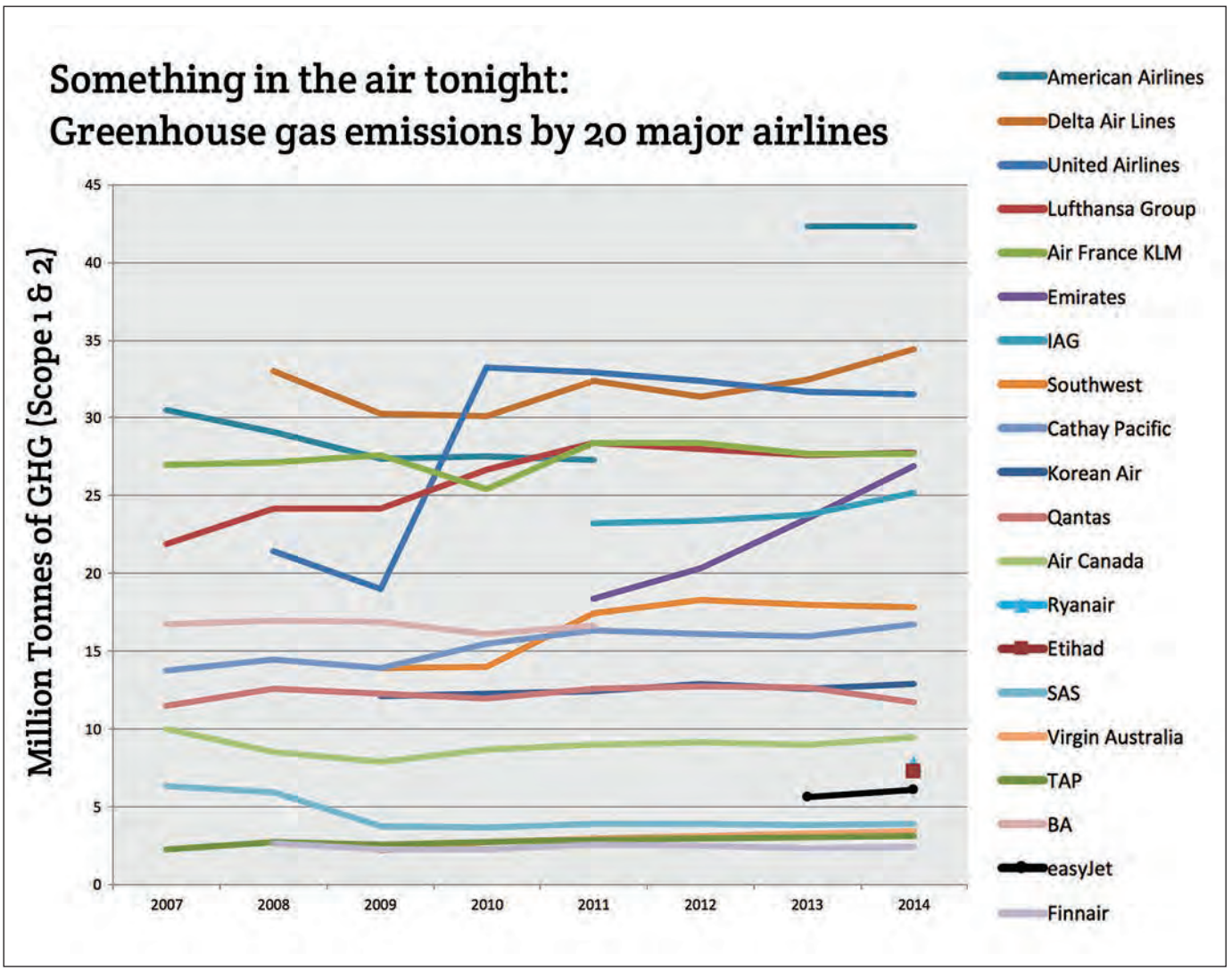
In the study, Finnair had the smallest carbon footprint in 2014, with TAP Portugal and Virgin Australia in the top three least polluting airlines, while American Airlines, following its merger with US Airways in 2013, had the largest footprint in the study with fellow US carriers Delta and United Airlines also large polluters in this sample.

Frederik Dahlmann, of Warwick Business School who conducted the study, said: "Finnair performed best due to the age and type of its planes, the routes it flies and the overall number of connections it offers. Plus it is probably among the most advanced when it comes to accounting for and managing its emissions over time."

Dahlmann examined data taken from 20 of the world's biggest airlines' annual reports and the Carbon Disclosure Project—a global voluntary carbon data reporting organization— to explore challenges airlines are facing.

Do you have news about your product or service?

Contact AMU's editor, John Campbell, at amu.editor@gmail.com ■



The GE9X: thinner

How large is the world's largest jet engine? So large that Shaquille O'Neil would fit inside it with Kobe Bryant sitting on his shoulders. Engineers at GE Aviation just assembled the first of these engines and put it on a test stand at the company's massive boot camp for jet engines located in the woods near Peebles, Ohio. It's a giant.

Above left: Testing the GE9X.
Above right: The GE90 powers many Boeing 777 jets, including this China Airlines plane.

is always **better**

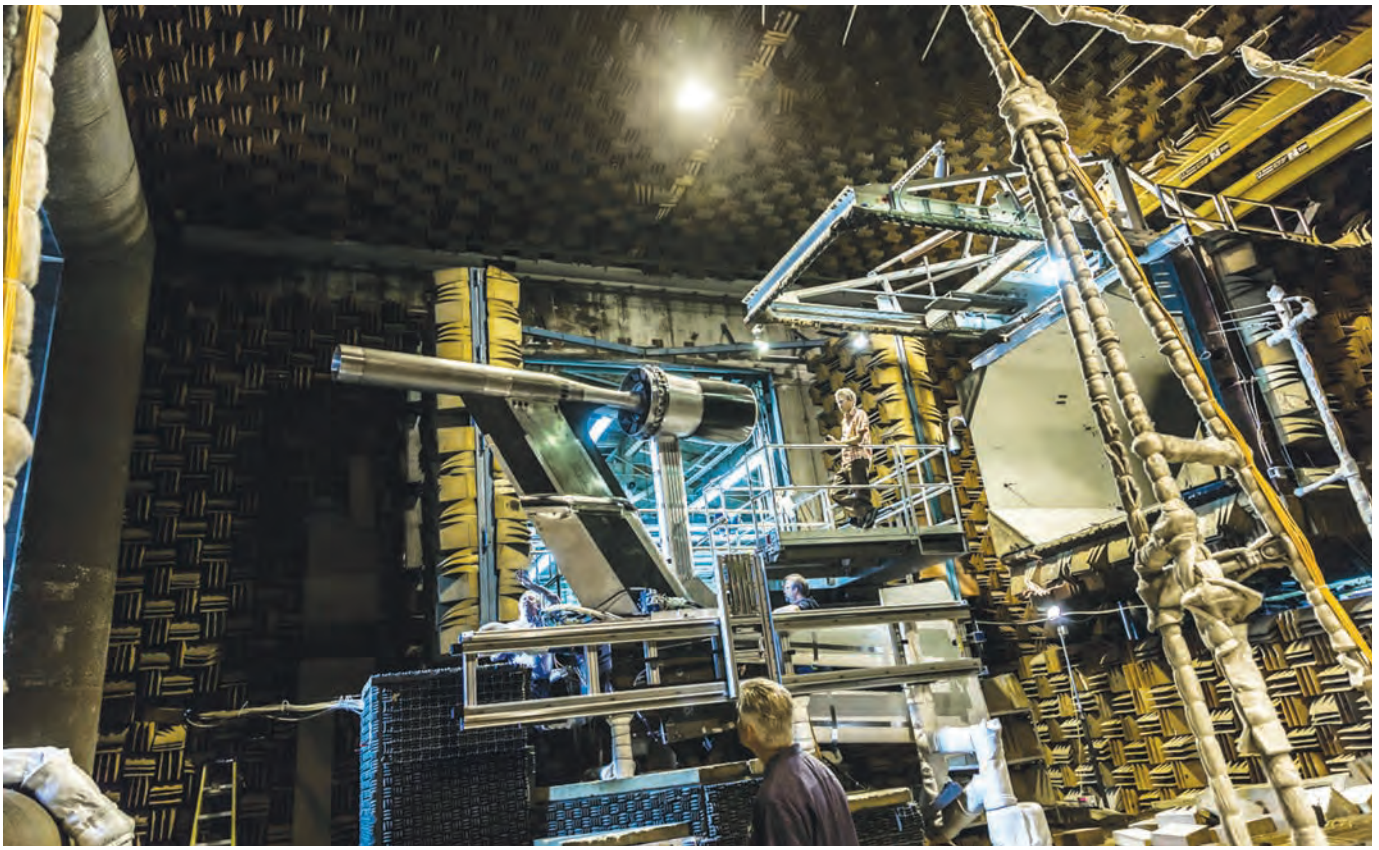
The brand new GE9X is a winner in several disciplines. Its front fan spans a full 11 feet in diameter (3.35 meters), a world record. The engine also has 3D printed fuel nozzles and the most extensive use of parts made from lightweight and ultra heat-resistant materials called ceramic matrix composites (CMCs).

Additive manufacturing, popularly known as 3D printing, essentially grows parts from the ground up and allows engineers to design complex internal shapes that were previously impossible to achieve.

"These tunnels and caves are a closely guarded secret," says GE Aviation spokesman Rick Kennedy. "They determine how the fuel moves through the nozzle and sprays inside the combustion chamber."

CMCs operate in temperatures as high as 2,400 degrees Fahrenheit. The material is inside the combustor and the turbine. It allowed engineers to keep the heat higher inside the engine while reducing fuel burn and emissions. "The hotter the engine runs, the more efficient it is," Kennedy says.

The engine also includes fourth-generation carbon-fibre fan blades at the front of the engine that feed air into an 11-stage high-pressure compressor with a 27:1 pressure ratio, which also boosts the engine's efficiency. No other commercial engine in service has a pressure ratio that's higher.



Above: GE has been testing the new design for the GE9X carbon fibre blades on a scaled-down testing rig at Boeing.

The carbon-fibre compostie blades allowed GE's aerospace engineers to design the GE90. "Our competitors make jet engine fans from titanium and steel and even some of our own people weren't initially so hot about using composites," says Nick Kray, who works as a consulting engineer for composite design at GE Aviation. In the 1990s, he was part of a GE high-stakes gambit to make the front fan of its largest jet engine from epoxy and carbon fibres. "Nobody had tried this before." The material allowed GE engineers to design blades that result in lighter and more efficient engines, allowing airlines to save fuel by shedding precious pounds.

The blades will feature several new components, Kray says. Their trailing edge will be made from a special structural glass fibre composite that can better absorb impact energy. "Carbon fibre is very stiff and not that flexible so that when a bird or something else hits the blade, it creates a shockwave deep inside it," Kray says. "But the glass composite can deform better and deflect stress on the blade."

GE will also replace the titanium leading edge that is currently used on GE90 and GEnx blades with steel. "It's a strong material that allows us to keep the new blade thin in shape to maximize performance," he says. "If you are an aero guy, thinner is always better. We want the best performance that's humanly possible."

Where the GE90 has 22 blades and the GEnx holds 18, the GE9X will have only 16, even though it is the largest of the three. Besides making the engine lighter, the fewer and thinner blades will also spin faster. "This is great for overall engine performance by matching the entire low pressure fan and turbine system to peak performance," Kray says. "It's something the engineers have been asking for."

The blades still retain their beautiful, sinuous curves, forward sweep, a hook at the top and the belly in the center. Says Kray: "It's an amazing technology."

When GE designed the GE90 carbon-fibre composite fan blade, it was not starting from scratch. In the 1980s, the company developed the experimental GE36 open rotor engine. It had used

Above: GE tests the design for the GE9X blades on a scaled-down testing rig at Boeing.

The GE36 was the first GE engine with composite blades. But they were on the outside.

carbon fibre composite blades in an unusual hybrid design that combined features from turbofan and turboprop engines.

Although the engine demonstrated fuel savings of more than 30 percent compared with similarly sized conventional jet engines, it did not catch on. Back in the lab, challenges abounded. Typical titanium blades absorb energy and bulge when they hit obstacles such as a bird. But ordinary composites can delaminate and break. "We didn't know how this new material would respond to stress," Kray says.

The team ran hundreds of intensive tests simulating bird strikes, rain, snow and hail storms at GE's jet engine boot camp in Peebles and the Wright Patterson Air Force Base, both in Ohio. "We'd test almost daily and make changes based on what we learned," Kray says. "The results gave us enormous confidence in the material when we saw how durable it was."

The GE90 blade (above) made its way to New York's Museum of Modern Art. Where the GE90 has 22 fan blades, the GE9X will have just 16 blades made from 4th-generation carbon fibre composite.

By 1993, the team had the right material and blade design, but they were far from done. They still had to produce it. GE Aviation teamed up with its European jet engine partner Snecma. The French aerospace company was experienced in making high-tech composites. They formed a joint-venture called CFAN and built a new composites factory in San Marcos, Texas.

Even with the help, making the blade was a hard climb. "The manufacturing of composites remains a manual process," Kray says. "The material goes through chemical changes and tends to move around. We had to learn how to get it right."

The workers inspected every single blade with X-rays, ultrasound, laser and other tools for defects. Initially, only 30 percent of them passed. (The current yield is about 97 percent.)

The Texas workers weren't learning about composites alone. GE also had to explain the material to regulators, and even to Boeing, who wanted to use it on its 777 long-range jet. The first one was scheduled to leave its plant in 1995. "On top of everything, we were racing against time," Kray says. "It was a very steep learning curve."

Ultimately, the wager paid off. Even though the GE90 engine had fan diameter of 128 inches, larger than its predecessors, the composites shaved 400 pounds off the machine. The GE9X's fan will be 134 inches in diameter.

The Federal Aviation Administration certified the engine and the composite blades in February 1995. "The engines essentially opened the globe up to incredibly efficient, twin-powered, wide-body planes," says David Joyce, president and CEO of GE Aviation.

The engine wasn't shy about showing its power and grace. In December 2002, the GE90-115B version of the engine achieved a Guinness World Record as the most powerful jet engine ever built, generating thrust in excess of 127,000 pounds – more than early space rocket engines. In 2005, a GE90-powered Boeing 777 set another world record, this time for distance traveled non-stop by a commercial jetliner. The plane covered 11,664 nautical miles between Hong Kong and London in 22 hours and 42 minutes. In 2007, the Museum of Modern Art in New York included the curved composite blade in its design collection.

Although this is the first time the company fired up the whole GE9X engine, it's been testing individual components and systems for four years. "Due to the significant amount of new technologies in the GE9X, we planned the testing program differently," says GE9X program leader Chuck Jackson. "The early testing informed the design and manufacturing and allowed us to freeze the product definition and test the total engine as soon as possible."

The GE9X was designed to generate 100,000 pounds of thrust. (One space shuttle main engine produces 375,000 pounds.) When Boeing decided to build the 777X jet, the next-generation version of the 777 jet, it asked GE to develop an engine to power it. GE Aviation, which is the exclusive engine maker for the 777X, has received orders for more than 700 GE9X engines valued at $29 billion (list price) from airlines including Emirates, Lufthansa, Etihad Airways, Qatar Airways and Cathay Pacific.

GE Aviation invested $10 million to prepare its Peebles Testing Operation for the GE9X. Some of the money paid for the largest "bellmouth inlet duct," the white funnel attached to the front of the engine during testing. It measures 18 feet in diameter and 12 feet in length.

Engineers also installed a fourth fuel tank to keep the engine well fed, fortified the bunker-like test stand to secure the engine and added new material to the testing stand air systems to withstand the high temperatures. "We also upgraded our engine hoists and transporters to handle the GE9X and modified a wall in our prep building so the engine can be moved after final assembly to make its way to the test stand," said Brian DeBruin, plant manager for GE Aviation's Peebles Test Operation.

GE Aviation started testing the first GE9X in March and will continue for several months in order to verify aerodynamic, thermal and mechanical characteristics of the engine. The company will start testing the second GE9X next year. The engine is scheduled to enter service by the end of the decade.

By the way, GE built the first U.S. jet engine in 1942. ■

open book exam 2016

AirMaintenance Update is Transport Canada-approved for recurrent training. This is our 14th exam, published annually in our June-July anniversary issue, in accordance with our agreement with Transport Canada. The exam consists of questions based on articles appearing in all six issues from the past year: June-July 2015, Aug.-Sept. 2015, Oct.-Nov. 2015, Dec.-Jan. 2016, Feb.-March 2016, and April-May 2016. You will require all six issues in order to write the exam. If you are missing any issues, call us at (604) 214-9824 or email us at amumag2015@gmail.com, and we will mail them to you at a cost of $7.95 per magazine postpaid.

A 75% pass rate is required in order to qualify for your 16 hours toward RT. The questions in the exam are arranged in order of their appearance in AirMaintenance Update according to issue and individual article. The exam can also be downloaded as an Adobe Acrobat PDF file via our website: www.amumagazine.com. Answers should be printed in the spaces provided and must be drawn directly from the text of the articles in order to be considered correct. All questions requiring a longer answer than the space allowed must be typewritten on a separate sheet of paper. Completed exams should be submitted to: AirMaintenance Update, Unit 7, 11771 Horseshoe Way, Richmond, BC, V7A 4V4. The exam must be postmarked no later than October 31, 2016. We will mark your test and return it along with documentation supporting your submission. We will keep a copy of your written test and results on file for future reference, and a copy will be forwarded to Transport Canada. Once again, good luck to all participants!

Your Contact Information

For a prompt and accurate response to your 2016 Exam answers, please fill in the following information (print clearly)

Name .....

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June - July 2015 (Volume 14/Issue 1)

The Evolution of a Light Jet

1) What powers the HondaJet?

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2) What unique configuration was developed to provide a larger space in the HondaJet's fuselage?

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3) What did Honda engineers develop to reduce drag and thereby achieve higher fuel efficiency in the HondaJet?

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4) What was the major design decision in the development of the HondaJet configuration?

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5) What did Honda engineers have to say about an over-the-wing engine-mount configuration versus the conventional rear-fuselage engine-mount?

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6) What was the main goal for the aerodynamic design of the HondaJet's wing?

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The Regs: No Word Yet

7) In Canada, what is a MPM?

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8) In Canada, what is the TATC?

.....

.....

9) What is probably the most valuable of our senses when it comes to snag analysis?

.....

10) A tell-tale whiff of fuel in an oil sample can be a clue towards what?

.....

11) What does secondary surveillance radar send from an ATC facility to transponder-equipped aircraft in the vicinity?

.....

.....

12) What does ADS-B allow aircraft to send and receive?

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Raising the Bar: Merely a Matter of Millimetres

13) What was the manufacturer-designated lifespan of the blades on Bell 206L helicopter C-GDQH?

.....

14) The main rotor blades on the Bell 206L are an all-metal bonded assembly consisting of what three structural members?

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15) What is bonded to the blade butt end on the Bell 206L?

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16) The TSB Laboratory concluded that the main rotor blades on Bell 206L helicopter C-GDQH were manufactured with defects. True or False?

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17) After the August 2008 occurrence of its 206L helicopter C-GDQH, what did Bell Helicopter implement?

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Aug. - Sept. 2015 (Volume 14/Issue 2)

Unleash the Power: MRO Data Management

1) What is needed when telemetry data analysis points to potential design issues?

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2) A data management strategy needs to account for what fact?

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Cleaned, Treated, and Good to Go

3) Wet blasting uses a suspension of solid particles in a carrier liquid to treat the surface of a material. True or false?

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4) During Wet Blasting, the "slurry" is mixed with a pressurized gas, and forced through what device?

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5) The liquid nature of wet blasting makes it what:?

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6) Preparing a surface for NDT comes at the most abrasive end of the wet blasting spectrum. True or False?

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7) What does Stokes' Law state?

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The Fly-By-Wire Chopper

8) In the case of the Bell 525 Relentless, what does Fly-by-Wire technology replace?

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9) What powers the Bell 525 Relentless?

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10) What helps keep the max gross weight of the Bell 525 Relentless under 20,000 pounds?

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11) The pilot cannot choose to decouple the flight director from autopilot and manually fly the Bell 525 Relentless. True or False?

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Raising the Bar: Didn't See This Coming

12) In the case of Sikorsky S-76A helicopter 760052, what sound was heard before the No. 2 engine lost power?

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13) What did the pilot do in response to the Sikorsky S-76A's power loss?

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14) The Sikorsky S-76A helicopter is certified up to what maximum gross take-off weight?

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15) What conclusion did the TSB reach about engine outer combustion in the Sikorsky S-76A helicopter 760052?

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16) The in-flight failure of Sikorsky S-76A helicopter 760052's outer combustion case resulted in a power loss. True or False?

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Oct. - Nov. 2015 (Volume 14/Issue 3)

The Regs: The World Before and After CAR 604

1) Which area of regulations does Transport Canada document AC-600-003 address?

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2) All aeroplanes required to have TAWS will have to be in compliance with the TAWS EAA requirements as of when?

.....

Life Status Update

3) The effects of hypoxia are completely different than the effects of alcohol. True or False?

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4) If an aircraft depressurizes suddenly, loss of consciousness can occur in a matter of what length of time? Seconds, minutes or hours?

.....

5) Hypoxia recognition systems are now being used to monitor which flight crew members?

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6) What kind of alerts will a hypoxia recognition system start to issue if it has not detected human activity over a given period of time?

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Flight of the Catbird

7) What world-record altitude did the Catbird reach on September 6, 1970?

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8) In the Catbird's "Description of the Flight" it was mentioned that the fuel air mixture setting at takeoff was not optimum. What was the result of that?

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9) The pilot of the Catbird says he made an error in the adjustment of the needle valve. What error did he make?

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10) What was the name of the first model aircraft to cross the Atlantic Ocean?

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Raising the Bar: Communication Breakdown

11) While an AME was conducting a maintenance ground run of Beech 1900D aircraft (C-GWGA) at Calgary Airport, the AME did not turn on the transponder. Consequently the controller did not assign what?

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12) What does a multilateration (MLAT) system for surface surveillance use to receive signals from transponders?

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13) Despite the incident involving Beech 1900D aircraft (C-GWGA), the Calgary Airport Authority still recognizes an AME's licence as sufficient authorization to tow or taxi an aircraft on the YYC airfield. True or False?

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Dec. - Jan. 2016 (Volume 14/Issue 4)

This Flight Tonight . . .

1) During Air Canada flight 797 on June 2, 1983, the DC-9's directional gyro failure meant the loss of what?

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2) Where are a DC-9's two JT8D engines located?

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3) A DC-9's engine-driven generators are each of producing how much power?

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Room for Twelve

4) What engines power the new Cessna Citation Longitude business jet?

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5) What is the factory-spec maximum cruise speed of the new Cessna Citation Longitude business jet?

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6) What will the Thales Group of Montreal provide for the new Citation Longitude?

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7) What does the "rudder-by-wire" system of the new Citation Longitude eliminate?

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8) Unfortunately the "rudder-by-wire" system creates a weight increase. True or False?

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Rise of the Real Time Sensors

9) When Bell 206B helicopter C-FZWB crashed, the helicopter's cabin and fuselage remained in one piece. True or False?

.....

10) When Bell 206B helicopter C-FZWB crashed, the main rotor head shaft had separated below the rotor head. True or False?

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11) When Bell 206B helicopter C-FZWB crashed, one main rotor blade remained attached to the rotor head. True or False?

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12) When Bell 206B helicopter C-FZWB crashed, there were indications the tail boom had struck a tree. True or False?

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13) When Bell 206B helicopter C-FZWB crashed, how was the aft section oriented?

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14) Loss of tail rotor effectiveness (LTE) is the occurrence of an un-commanded yaw rate that does not subside of its own accord and, which, if not corrected, can result in the loss of the helicopter. True or False?

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15) The examination of Bell 206B helicopter C-FZWB revealed many mechanical issues with the helicopter. True or False?

.....

16) As the pilot of Bell 206B C-FZWB progressively reduced speed, the helicopter became increasingly vulnerable to LTE. True or False?

.....

17) The damage to the under-surface of the main rotor blades indicated that the pilot of Bell 206B helicopter C-FZWB did not attempt to increase his collective control input in an effort to power out of the area. True or False?

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Feb. - Mar 2016 (Volume 14/Issue 5)

The Replacements: Boeing's 737 MAX Family

1) The 737 MAX will retain significant spares commonality with the Next-Generation 737. True or False?

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2) The 737 MAX will emit over 310,000 fewer tons of carbon dioxide. True or False?

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3) The 737 MAX will be powered by what engines?

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4) The 737 MAX engines have been moved up and forward on the wing. True or False?

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5) The 737 MAX has a fly-by-wire spoiler system. True or False?

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6) Boeing says the737 MAX's electronic bleed air system does not contribute to fuel efficiency. True or False?

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Raising the Bar: Tripped on a Wire

7) Beechcraft King Air A100 aircraft C-FEYT has tricycle landing gear that is operated via what?

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8) By what are the main landing-gear actuators of Beechcraft King Air A100 aircraft C-FEYT driven?

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9) Depending on the direction of rotation from the gearbox, the landing gear of Beechcraft King Air A100 aircraft C-FEYT can extend or retract. True or False?

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10) After Beechcraft King Air A100 aircraft C-FEYT's landing-gear shaft system seized and the two generators were disabled, the aircraft still had numerous other sources of electrical power. True or False?

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11) What is the normal length of time a fully charged battery is expected to power aircraft systems?

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12) During the Beechcraft King Air A100 aircraft C-FEYT's landing-gear extension, the rotating torque shaft that drives the screw jack actuators to lower the landing gear caught on what?

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13) With the landing gear disabled, the crew of Beechcraft King Air A100 aircraft C-FEYT was therefore required to do what?

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14) What was the precaution taken after the incident involving Beechcraft King Air A100 aircraft C-FEYT?

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April - May 2016 (Volume 14/Issue 6)

Final Flight of the Prototype

1) Boeing's 727-100 was the only type of Boeing commercial jet with no dedicated prototype. True or False?

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2) How many JT8D engines powered Boeing's 727-100?

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3) What was involved in Phase Three of the restoration of Boeing's 727-100, N7001U?

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The Regs: Canada Transportation Act Review

4) The Canada Transportation Act Review recommends a package of measures that address the three major components of competitiveness. What are those three components?

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5) According to the Review, airport rents in Canada can represent up to 30 percent of airport operating budgets. True or False?

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6) According to the Review, Canada has collected approximately $5 billion in airport rent since 1992. True or False?

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7) T The Review recommends phasing out airport rent and increasing capital funding available to smaller airports. True or False?

.....

Raising the Bar: Shake, Rattle, and Roll

8) Kamov Ka-32A11BC, C-GKHL has counter-rotating rotors (two main rotors, stacked on top of one another, turning in opposite directions). True or False?

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9) Kamov Ka-32A11BC, C-GKHL has a tail boom. True or False?

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10) To induce yaw in Kamov Ka-32A11BC, C-GKHL, torque to one rotor is increased while torque to the other rotor is also increased. True or False?

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11) When TSB Laboratory examined the engine components of Kamov Ka-32A11BC, C-GKHL, it was discovered that all of the blades in the Compressor Turbine (CT) were just fine. True or False?

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12) Detailed examinations of Kamov Ka-32A11BC, C-GKHL's CT section components revealed manufacturing anomalies. True or False?

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13) The anomalies in the first stage guide vane retention ring would have allowed the guide vanes to do what?

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14) The hole on the low-pressure side of one of the guide vanes may have added to the gas flow pattern changes. True or False?

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AirMaintenance Update

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ONTARIO

AME Association of Ontario

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email: association@ame-ont.com website: www.ame-ont.com

Gray Tools launches special cooperation with AME Association of Ontario

The AME Association of Ontario is pleased to announce a special co-operation with Gray Tools Canada. The cooperation will offer AME Association members special purchase and rewards advantages not available to non AME members. The program rewards AME Association members on tool purchases made on the Gray Tools online store (www.shopgraytools.com). Purchases made on the web store will earn participating members points redeemable for discounts on future purchases. Ten points are earned for each $1 spent online (before taxes and shipping); equivalent to 10 percent in free goods. AME Association members will earn points at twice the rate of non-group members The initiative runs exclusively online. Participation in the program is voluntary.

In addition to the enhanced points rewards program exclusive promotions will be made available to OAMEA members throughout the year.

Here are some other new member benefits:
Safety Gear: 15 percent discount from Work Authority (with a discount card available from the AME Association Membership Director).

Are you in the market for a new or used Chrysler/Dodge/Jeep or need Service or Mopar Parts for your Chrysler car? Contact Downsview Chrysler and ask for the AME Association of Ontario discount (25 percent).

Looking for value for your Family Entertainment and Travel Dollars? Then check out Perkopolis for some excellent deals: www.perkopolis.com

Annual Workshop/Symposium

Our annual Symposium and Workshops are to be held Wednesday and Thursday, September 28th and 29th. The exhibitors will set up Tuesday evening. This is a change from previous years when our workshop was held Thursday and Friday. The workshop committee expects that by moving the operations forward by one day, it will be more convenient for exhibitors, speakers and attendees. Again, this year we will be having two days filled with educational sessions as well as a full house of displays from industries supporting aircraft maintenance. Check our website at www.ame-ont.com for all the details.

Licence Renewal

A reminder that you should renew your AME licence prior to the expiry date. The renewal fee is $40, however if you miss the deadline it will cost you $115 to renew. A licence being renewed one year after the deadline will still cost you $155, but you will also have to write and pass the CARs exam and pay the appropriate fee for its administration and correction. It can get expensive.

So next time you renew your driver's licence or car plates, check your AME Licence expiry. It's easy to renew. Just $40 cheque or credit/debit card (they do not take cash any more), fill in form 24-0083 and supply a photo which you can take with your own digital camera. Details can be found on the web at: www.tc.gc.ca/eng/civilaviation/standards/maintenance-aarpb-general-renewal-2543.htm

I filled in the form and brought it to my regional office earlier this week. I was served by friendly staff who took my photo, gave me a receipt for the credit card payment and I was out within 10 minutes. I expect to have my new licence in the mail by the end of next week.

Submitted by Stephen Farnworth for the Board of Directors

PACIFIC

Pacific AME Association

About Us

PAMEA is a non-profit association comprised of aircraft maintenance engineers, aircraft maintenance personnel and aviation industry corporate members. PAMEA is an active member of the Canadian Federation of AME Associations (CFAMEA).

www.pamea.ca
email: pamea@telus.net

Atlantic AME Association

News from the Rock

By Mel Crewe

Nalcor Energy Air Services has been an outstanding supporter of the Atlantic Region Aircraft Maintenance Conference and the A.M.E. Association (Atlantic) Inc. over the years. We really appreciate their past support and look forward to continuing that relationship into the future. I am pleased to announce that one of our members and a former Executive member of the Association has had a street named in his honour. Mayor Claude Elliott of the Town of Gander has just announced that a street in the new subdivision in Gander has been named Briggs Street in honour of Gander resident Bob Briggs. Bob has been President of the North Atlantic Aviation Museum for 13 years. He has received the Earl Blakney Aviall Canada Ltd. Award for outstanding performance in aircraft maintenance, and he was inducted into the Canadian Aircraft Maintenance Hall of Fame in 2004. Bob launched his own repair business known as Briggs Aero in 1980. He has his own pilot's licence and is an avid motorcyclist. Congratulations, Bob, from all the members of the Association.

I was the proud recipient of an award from the Newfoundland and Labrador Brain Injury Association, in recognition of my volunteer work with the Association. I do all the photography for the Association at its formal functions and the annual golf tournaments. I was among over 40 volunteers recognized by the NLBIA and presented with awards by His Honour Frank Fagan, Lieutenant Governor of Newfoundland and Labrador at a ceremony at Government House in June 2015.

www.atlanticame.ca

ATLANTIC

Western AME Association

About Our Association

The Western AME Association is one of five similar associations across Canada, and is run by a volunteer group of AMEs who are elected by the member AMEs to the Board of Directors. The membership is comprised of AMEs, non-licensed personnel working in the industry, students and apprentices as well as corporate members. A separate committee, under the auspices of the association, runs an annual symposium/workshop. This workshop is a two-day event that features speakers on a variety of related topics, as well as an industry tradeshow with over 50 booths from various companies, suppliers, manufacturers and other organizations. Attendance at this and our various other smaller workshops may be counted towards the recurrent training requirements required by Transport Canada.

www.wamea.com

WESTERN

Central AME Association

The Central Aircraft Maintenance Engineer Association is an organization dedicated to maintaining and enhancing the standards, rights and privileges of all AME members in the central region of Canada.
The objectives of our Association are:

1. To promote and protect the profession of the Aircraft Maintenance Engineer
2. Develop, maintain and improve representation and consultation with regulatory bodies that affect the profession of the Aircraft Maintenance Engineer
3. To represent the views and objectives of the membership of the association
4. Promote and develop the knowledge, skill and proficiency of AMEs through education, publications and research.
5. Cooperate and associate with groups, associations and organization on matters of mutual interest.
6. To promote honorable practices among the membership and between persons in the aviation industry

www.camea.ca

CENTRAL

DFW

PAMA Dallas – Fort Worth

About Us

The DFW Chapter of PAMA is a non-profit association dedicated to promoting professionalism and the recognition of the Aviation Maintenance Technician through communication, education, representation and support, for continuous improvement in aviation safety.

email: curtislandrum@charter.net

www.pamadfw.com

PAMA SOCAL

PAMA SoCal Chapter

February 2016 Meeting Wrap

The SoCal Chapter thanks Bill Johnston, President and Larry Hinebaugh, Founder and all at V-Log, LLC for their time and generosity in hosting the February 2016 Chapter dinner meeting and excellent technical presentation on "LogBook Best Practices, Twelve Common Logbook Mistakes and How to Avoid Them!" at the 94th Aero Squadron Restaurant in Van Nuys, CA. To learn more about how V-Log can provide peace-of-mind protection as well as easy access to your logs and maintenance records, contact Bill (Bill@vlog.aero), Larry (Larry@vlog.aero) or visit www.vlog.aero.

www.socalpama.org

CENTRAL OHIO

Central Ohio PAMA

May 10th Meeting topic: FreeFlight Systems, What is ADS-B?

Our May 10th meeting featured a presentation by FreeFlight System's Ashley Kelley and included a review of the 2020 mandate, the equipment required for the various types of aircraft and a showcase of FreeFlight Systems equipment offerings. Ashley started her program with a history of their company, which started as Trimble Navigation. Founded in 2001 through the acquisition of Trimble Navigation's Avionics Products Division, FreeFlight Systems is an international supplier of quality avionics at affordable prices. With a focus on safety, simplicity, and reliability, FreeFlight Systems offers a broad array of GPS navigation systems, GNSS/SBAS sensors, radar altimeters, and ADS-B components and systems worldwide.

She spoke of their equipment lines from the simplest units capable of meeting the mandate requirements to units TSO certified for up to Part 25 aircraft and Helicopters. She explained the ADS-B cell tower based ground stations and ADS-B Our and In capabliities.

Their website not only features information about their equipment and the Approved Modification Lists (AML) for STC installations but also features ADS-B University for information on the subject. Their Equipit2020 Site lists equipment and costs for the various units. A price increase is due this July, so contact them for information on purchasing now or locking in a serial number for your future installation.

We wish to thank Ashley and FFS for her informative presentation. Those who registratered through the FAASTeam website and will receive credit toward AMT Award and WINGS program. This was the last regular meeting before the summer break.

See you in the fall for COAGO 2106 in September and our first meeting of the fall in October!

April 12th Meeting: Introduction of the GE Honda HF120 Engine

Our April meeting featured a presentation by Mr. Steve Shaknaitis, President of GE Honda Aero Engines, on their HF120 engine for the new HondaJet aircraft. Steve's presentation began with a history of General Electric and his background as an aerospace engineer in their GE90 engine development program for the Boeing 777. He also reviewed General Electrics other product lines and their Joint Venture with Honda to create GE Honda Aero Engines.

The HF120 turbofan was developed from the company's original HF118 design. The engine produces 2,050 lbf of takeoff thrust and is being built in their Burlington, North Carolina, plant. They are looking beyond the HondaJet platform to power other lightweight jets in both twin and single engine installations.

The HondaJet recently received FAA certification and now is pursuing certification for Flight Into Known Icing. The aircraft leading edges and engine inlets are heated by bleed air from the twin HF120s. The engines have achieved over 23,000 hours of ground and in-flight testing with the first four HondaJet aircraft being dedicated test beds for certification.

We want to thank Mr. Shaknaitis for the insight on their new engine, Mr. James Kulp of GE Aviation for arranging this presentation and standing in reserve to back up and Lane Aviation for use of their facility.

www.copama.org

First One Out *Kiss the Runway*

BY AL WALSH

In 'DC-3 Memories' in the February-March issue, Sam Longo shared his experience as a young AME working with the rugged old Douglas aircraft. Sam's story inspired retired AME Al Walsh to share one of his own. Here, Mr. Walsh recounts a harrowing flight through whiteout conditions and with one engine puking oil.

On December 11, 1964, a Douglas DC-3 aircraft was on a cross-country flight plan from Ottawa Uplands Airport to CFB Comox Airport, British Columbia. The DC-3 aircraft was powered by two Pratt and Whitney 1830 radial engines with two stage impeller blowers.

The altitude ceiling of 21,000 feet would allow it to cross the Canadian Rockies and climb above inclement weather should the situation arise. The crew consisted of the pilot-in-command, co-pilot and two crewmen — one of whom was doing a proficiency check ride on me.

We departed Uplands Airport on the first leg of the flight, and after five hours and 15 minutes, arrived at what was then Fort William, Ontario, where we refueled the aircraft, did the between-flight check, and departed Fort William, arriving inWinnipeg two hours and 40 minutes later. Again, we refueled the aircraft, made the between-flight inspection and left for Calgary, arriving there in five hours and 40 minutes.

"At the time I didn't know what a hockey stick turn meant, but it worked, and the DC-3 was now tracking to the Lethbridge Airport in whiteout conditions. There was simply no visibility, and all three of us were on lookout for a break out of some kind to the airport."

During the between flight inspection at Calgary a rocker cover oil leak was rectified. We took a bit longer than normal to repair the oil leak due to a mishap that caused the check crewman to injure his back. With the fix made we departed for Comox from Calgary with a total of six people. A briefing was given to all personnel by the captain on the use of oxygen, as we would be flying at an altitude of 21,000 feet ASL.

Shortly after departing Calgary we encountered turbulence while climbing to altitude. The weather persisted as we climbed through 10,000 feet and at this point oxygen masks were issued to the PAX and crew as we continued climbing to altitude in an effort get above the snowstorm and westerly headwinds.

As the DC-3 was approaching 19,000 feet the captain called me on the headphone to come forward to the cockpit. At this point we were being battered quite fiercely in the snowstorm and the headwinds were increasing drastically. I struggled up to the cockpit and the pilot pointed to the oil pressure gauge pressure at 50 PSI and fluctuating. The oil pressure at normal runs at 73 PSI and/or -2 PSI.

The pilot asked what I thought the problem was and I replied that, hopefully, the gauge was giving an erratic reading or the transmitter was unserviceable or, worse-case scenario, there was a real oil leak.

I struggled back to visually check the L/H engine and wing trailing; there was no evidence of a leak. While back in the cabin compartment I checked the passengers and injured crewman, and the situation was serious. The nursing sister

was in tears, the medical officer in distress, and the crewman was in severe pain. I did as much as I could for the PAX and headed back up front to the cockpit.

On my way to the cockpit I took a look at the L/H engine and thought 'Oh my God!' the oil was streaming off the trailing edge of the wing. On reaching the cockpit I looked at the oil pressure gauge and pressure was below 50 PSI and fluctuating. I spoke to the captain and said, when the pressure reaches 30 PSI, push the feather button for the L/H engine and hope the propeller feathers or we are in a trouble.

When the pressure reached 30 PSI I tapped the captain on the shoulder. He pushed the feather button and the magnets held the button in and glowing red as it was supposed to do. I struggled back to my crewman's seat in time to see the prop blades go to the feather (fine) position. It was great relief to see the L/H propeller feathered but now on single engine we were losing altitude rapidly, leveling out at 9,000 feet.

Mount Kimberly is 11,000 feet and we were in the vicinity, which was a great concern. The snowstorm at this 9,000 feet level was at its worst, 80 knots on the nose, and kicking the DC-3 all over the sky.

Kimberly Radio has us on radar and said we looked like we were standing still. Meanwhile the co-pilot was doing the mathematics, our indicated air speed was 140 knots, wind on the nose 80 knots which computed our ground speed at 60 knots forward speed. The computations were such that at 60 knots we were not up to Mount Kimberly and the captain made the decision to turn around and track east.

From 80 knots on the nose to 80 knots half on the tail, we were really moving over the Earth's surface: around 200 knots or thereabouts.

We picked an automatic direction finder (ADF) signal to Lethbridge Airport; the beeps in my headset were loud and clear and we are on track for the ADF beacon. The snow squalls and wind were relentless, and the pilot worked hard at the DC-3 controls while the airplane was buffeted continuously.

The captain asked me to monitor the ADF gauge. When the needle swung around I was to tap him on the shoulder. It would be the signal to him that we had passed over the ADF ground transmitter. It seemed like an eternity but the needle finally swung and I tapped his shoulder. At that point he commenced a hockey stick turn: up the handle for one minute then a turn onto the blade of the hockey stick.

At the time, I didn't know what a hockey stick turn meant, but it worked, and the DC-3 was now tracking to the Lethbridge Airport in whiteout conditions. There was simply no visibility, and all three of us were on lookout for a break out of some kind to the airport. Finally the co-pilot shouted, "I have it!" and virtually forced the DC-3 through a hole in the diminishing snow and landed the aircraft. As we stopped in the middle of the runway I heard the captain say, "First one out kiss the runway."

I lowered the air stair, stepped out and down the stairs to see black oil covering the lower fuselage. It was an immense relief to be over that ordeal, and terra firma never felt so good to any of us. The venerable DC-3 piloted by a couple of

Douglas DC-3 cockpit: "The captain asked me to monitor the ADF gauge. When the needle swung around I was to tap him on the shoulder. It would be the signal to him that we had passed over the ADF ground transmitter."

professional pilots carried us through the worst weather on record and with one engine feathered.

The DC-3 was towed to a large hangar at Lethbridge and bedded down for the night. A crew arrived from Edmonton with a spare engine and we set about to change engines. The component, cooling baffle and all QEC parts were switched from the old engine to the new engine. With the installation of the engine aircraft completed, run up was serviceable and on December 16 we departed for Calgary and then back to Ottawa. In total, the crew flew 28 hours and five minutes, though we never did reach Comox.

On the brighter side, while in Lethbridge I phoned my wife in Ottawa. I said we did not make Comox due to the loss of the left engine. Not knowing aircraft slang or terminology she asked, "Did it fall off?"

At any rate we were glad to be home safely after the experience of a lifetime. The DC3 is truly an amazing aircraft, having carried us safely through such an experience. ■

Nowhere to Go BUT UP

Boeing's Current Market Outlook is a comprehensive White Paper that studies the short- and long-term impacts of global trends, economics, and market demand on the aviation industry. The publication takes the position that 2015-2034 will see record growth in which the demand for pilots and technicians will be unprecedented. Here are excerpts.

For the aviation industry, 2014 was an outstanding year — key metrics increased across the board, and we will continue to see this trend, with lower oil prices expected to save the industry tens of billions of dollars in one year alone. Passenger traffic as measured by revenue passenger kilometers (RPK) was up nearly six percent in 2014, and capacity was up nearly 5.8 percent. The result was record load factors of almost 80 percent worldwide. Airlines continued using their airplanes more efficiently, as demonstrated by utilization rates that were 15 percent higher than those of a decade earlier. Because of lower oil prices and various increased efficiencies, airlines had profits of US$20 billion during 2014, which was also a record year for airplane manufacturers such as Boeing and Airbus. Over 1,490 jet airplanes were delivered, and airlines ordered approximately 3,680 new airplanes.

Global economic expansion is expected to continue, and although the overall picture is good, there will be regional challenges. North America is leading the economic global acceleration, and the Eurozone is finally starting to gain economic momentum.

In the past, emerging markets have driven economic growth, but we are now starting to see some regional divergence from this trend. Based on these and other market indicators, our near-term 2015 forecast was for RPK growth to exceed six percent, with cargo traffic growth accelerating above five percent. The bottom line is that with a favourable cost environment and strengthening demand, many airlines would see opportunities for record profits in 2015.

Our long-term outlook incorporates the effects of market forces on the growth of the aviation industry. Based on what has happened historically and what is expected to occur, world GDP is anticipated to grow at 3.1 percent annually over the next 20 years. During this period, passenger traffic is forecast to grow by 4.9 percent and air cargo traffic by 4.7 percent.

Over the next 20 years, we are forecasting a need for 38,050 airplanes valued at more than $5.6 trillion. Aviation is becoming more diverse, with approximately 40 percent of all new airplanes being delivered to airlines based in the Asia Pacific region. An additional 20 percent will be delivered to airlines in Europe and North America, with the remaining 20 percent to be delivered to the Middle East, Latin America, the Commonwealth of Independent States, and Africa.

Single-aisle airplanes command the largest share of new deliveries, with airlines needing approximately 26,730. These new airplanes will continue to stimulate growth for low-cost carriers and will provide needed replacements for older, less-efficient airplanes. In addition, widebody fleets will need an additional 8,830 new airplanes, which will allow airlines to serve new markets more efficiently than in the past.

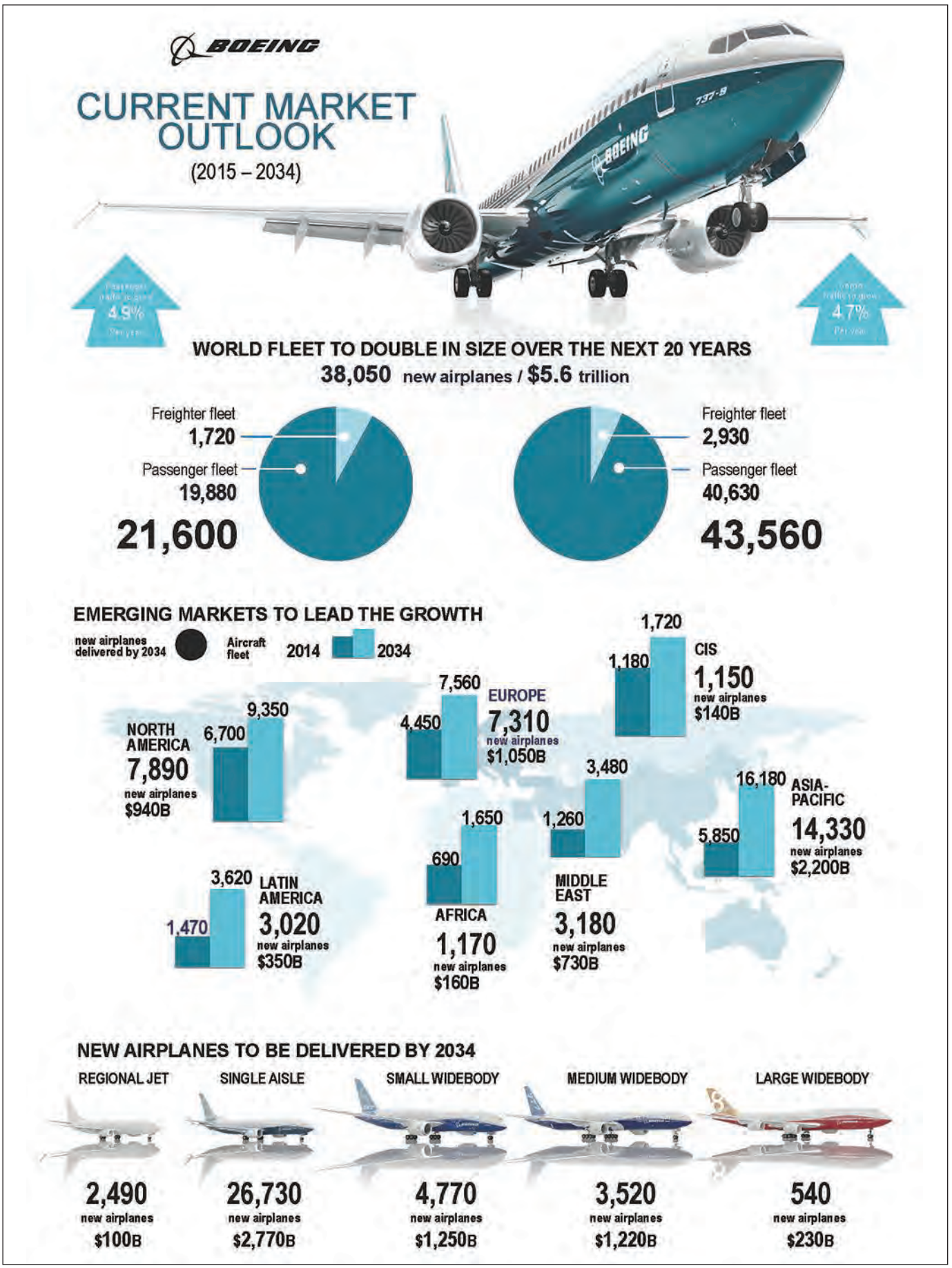
Demand unprecedented for pilots and technicians

As global economies expand and airlines take delivery of tens of thousands of new commercial jetliners over the next 20 years, there will be unprecedented demand for people to pilot and maintain these airplanes. To meet this tremendous growth, the 2015 Boeing Pilot and Technical Outlook forecast was that between now and 2034, the aviation industry will need to supply more than one million new aviation personnel—558,000 commercial airline pilots and 609,000 maintenance technicians.

Meeting this exponential demand for personnel will require innovative solutions that rely on the latest digital technology to match the learning requirements of a new generation. Trainers will thus focus on enabling airplane operators to gain optimal advantage of the advanced features of the latest generation of airplanes, such as the 787 Dreamliner, 737 MAX, and the 777X. And instructors will need to have cross-cultural and cross-generational skills to engage tomorrow's increasingly diverse aviation workforce.

Economic expansion fueling aviation demand

Airlines around the world are expanding their fleets and flight schedules to meet the global economic expansion. The aviation industry continues to address these challenges by creating a balanced, sustainable solution to filling the future pilot

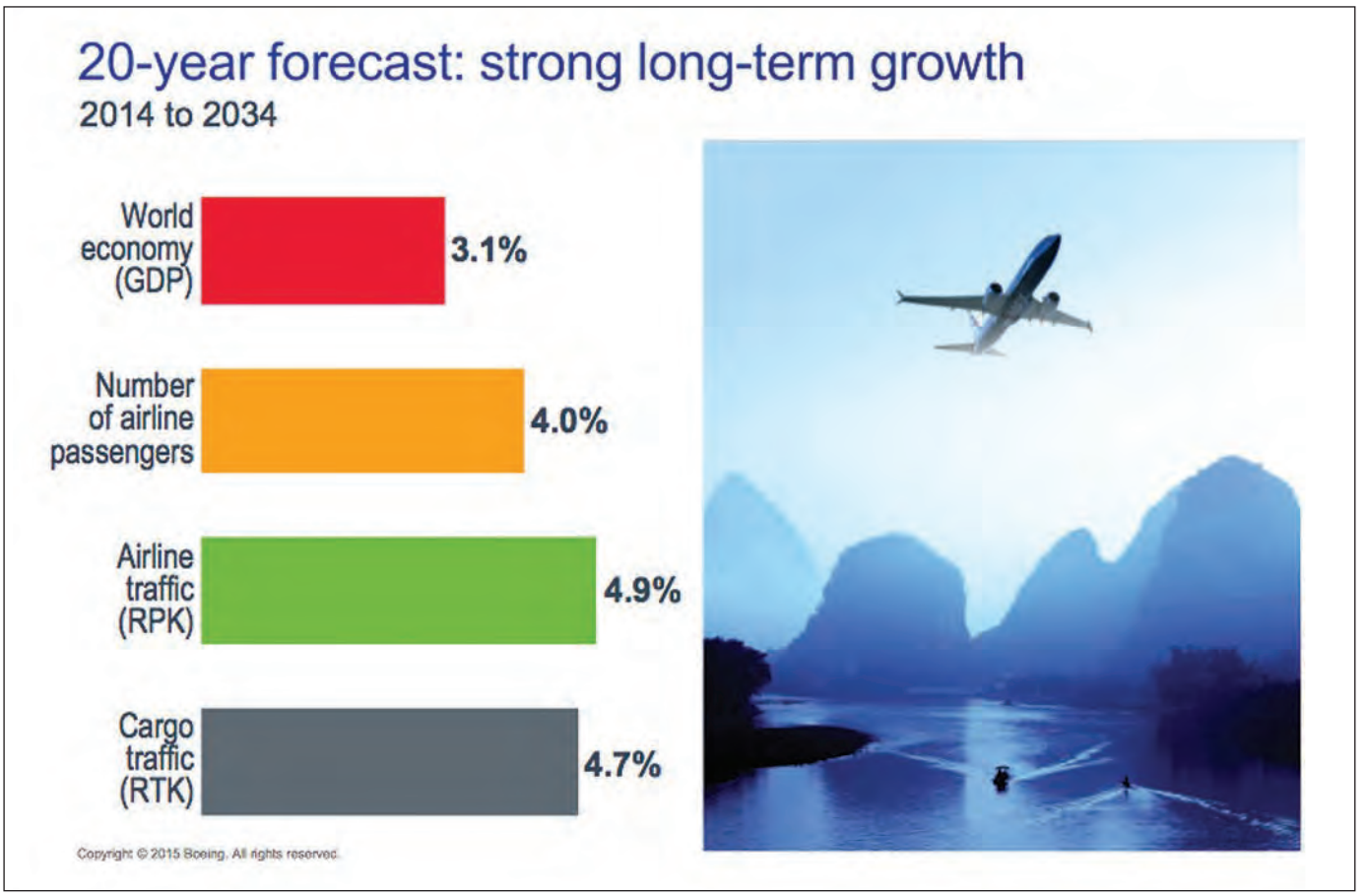

BOEING
CURRENT MARKET OUTLOOK
(2015 – 2034)
4.9%
4.7%
WORLD FLEET TO DOUBLE IN SIZE OVER THE NEXT 20 YEARS
38,050 new airplanes / $5.6 trillion
Freighter fleet
1,720
Passenger fleet
19,880
21,600
Freighter fleet
2,930
Passenger fleet
40,630
43,560
EMERGING MARKETS TO LEAD THE GROWTH
new airplanes delivered by 2034
Aircraft fleet
2014
2034
NORTH AMERICA
6,700
9,350
7,890
new airplanes
$940B
EUROPE
4,450
7,560
7,310
new airplanes
$1,050B
CIS
1,180
1,720
1,150
new airplanes
$140B
ASIA-PACIFIC
5,850
16,180
14,330
new airplanes
$2,200B
LATIN AMERICA
1,470
3,620
3,020
new airplanes
$350B
AFRICA
690
1,650
1,170
new airplanes
$160B
MIDDLE EAST
1,260
3,480
3,180
new airplanes
$730B
NEW AIRPLANES TO BE DELIVERED BY 2034
REGIONAL JET
2,490
new airplanes
$100B
SINGLE AISLE
26,730
new airplanes
$2,770B
SMALL WIDEBODY
4,770
new airplanes
$1,250B
MEDIUM WIDEBODY
3,520
new airplanes
$1,220B
LARGE WIDEBODY
540
new airplanes
$230B

and technician pipeline. Regional markets that have relied heavily on recruiting pilots from outside their home locations will increasingly require a strong foundation for developing and training qualified pilots locally.

Asia Pacific remains the region with the highest overall demand—some 40 percent of the world's required pilots and technicians—but the anticipated number of skilled resources required in other parts of the world, such as the Middle East and Latin America, has significantly increased.

Asia Pacific leads future pilot demand

Taking a closer look at the numbers, the largest projected growth in pilot demand is, as stated, in the Asia Pacific region, which will require an estimated 226,000 new pilots over the next 20 years. Europe and North America will each require 95,000 new pilots; the Middle East, 60,000; Latin America, 47,000; the Commonwealth of Independent States (CIS), 17,000; and Africa, 18,000.

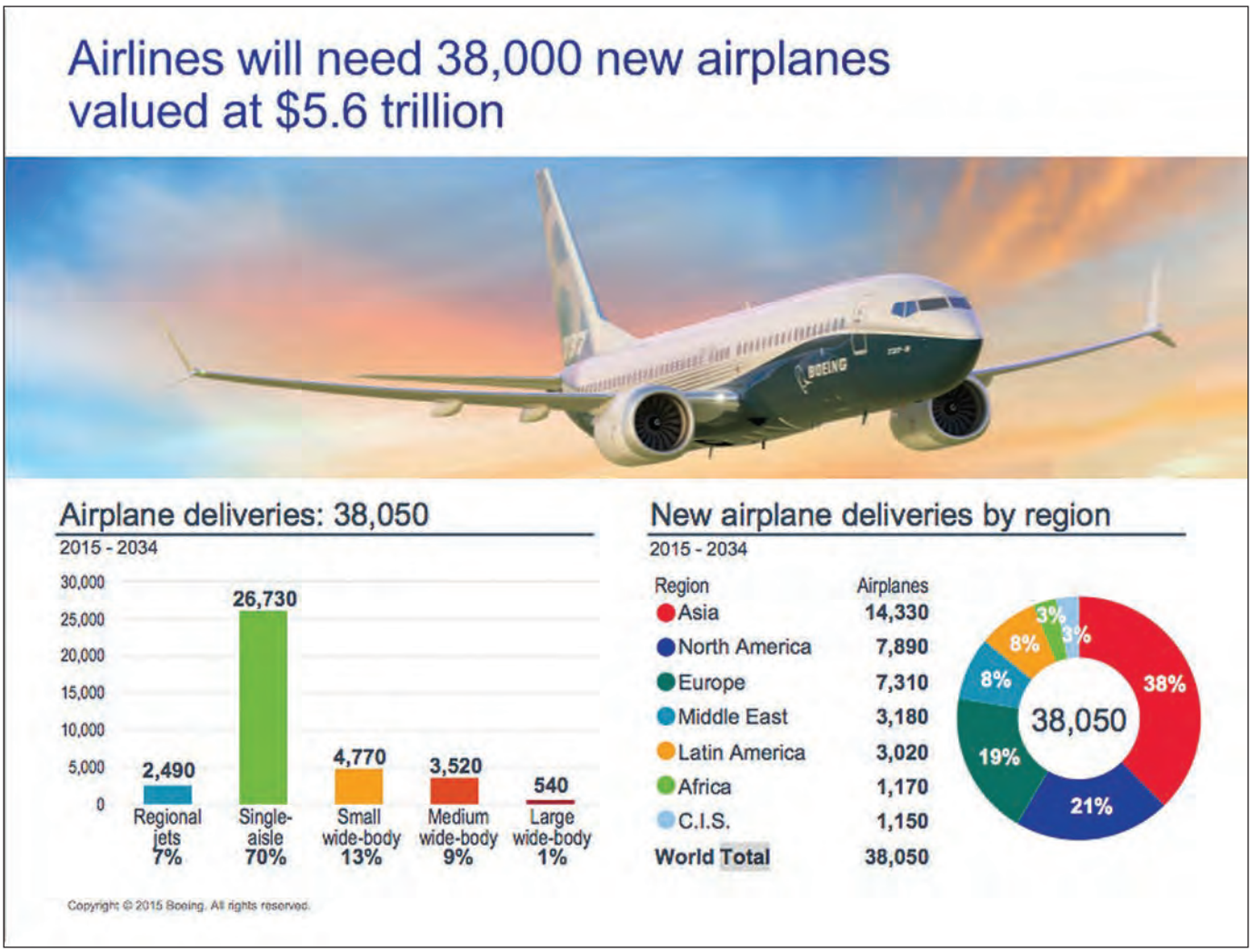


CURRENT MARKET OUTLOOK ON A PAGE

2015-2034

BOEING

Regions		Asia	North America	Europe	Middle East	Latin America	C.I.S.	Africa	World
World economy	(GDP) %	4.3%	2.5%	1.8%	3.8%	3.4%	2.4%	4.5%	3.1%
Airline traffic	(RPK) %	6.1%	3.1%	3.8%	6.2%	6.0%	3.7%	5.7%	4.9%
Cargo traffic	(RTK) %	5.7%	2.9%	3.1%	6.3%	5.5%	3.7%	6.9%	4.7%
Airplane fleet	%	5.2%	1.7%	2.7%	5.2%	4.6%	1.9%	4.5%	3.6%
Market Size									
Deliveries		14,330	7,890	7,310	3,180	3,020	1,150	1,170	38,050
Market value ($B)		2,200	940	1,050	730	350	140	160	5,570
Average value ($M)		150	120	140	230	120	120	140	150
Unit share		38%	21%	19%	8%	8%	3%	3%	100%
Value share		39%	17%	19%	13%	6%	3%	3%	100%
New Airplane Deliveries									
Large widebody		140	20	40	300	-	40	-	540
Medium widebody		1,530	490	510	880	30	40	40	3,520
Small widebody		1,920	690	910	560	310	120	260	4,770
Single aisle		10,370	5,070	5,770	1,410	2,520	760	830	26,730
Regional jets		370	1,620	80	30	160	190	40	2,490
Total		14,330	7,890	7,310	3,180	3,020	1,150	1,170	38,050
Market Value (2014 $B catalog prices)									
Large widebody		60	10	20	130	-	10	-	230
Medium widebody		520	170	180	310	10	20	10	1,220
Small widebody		500	170	250	150	90	30	60	1,250
Single aisle		1,110	520	600	140	240	70	90	2,770
Regional jets		10	70	-	-	10	10	-	100
Total		2,200	940	1,050	730	350	140	160	5,570
2014 Fleet									
Large widebody		280	100	180	110	-	60	10	740
Medium widebody		530	320	350	300	30	30	60	1,620
Small widebody		780	730	380	250	130	170	80	2,520
Single aisle		4,130	3,850	3,240	540	1,220	730	430	14,140
Regional jets		130	1,700	300	60	90	190	110	2,580
Total		5,850	6,700	4,450	1,260	1,470	1,180	690	21,600
2034 Fleet									
Large widebody		180	60	100	260	-	70	-	670
Medium widebody		1,620	530	550	900	40	90	70	3,800
Small widebody		2,270	910	1,070	660	380	210	300	5,800
Single aisle		11,730	6,190	5,730	1,600	3,020	1,140	1,220	30,630
Regional jets		380	1,660	110	60	180	210	60	2,660
Total		16,180	9,350	7,560	3,480	3,620	1,720	1,650	43,560

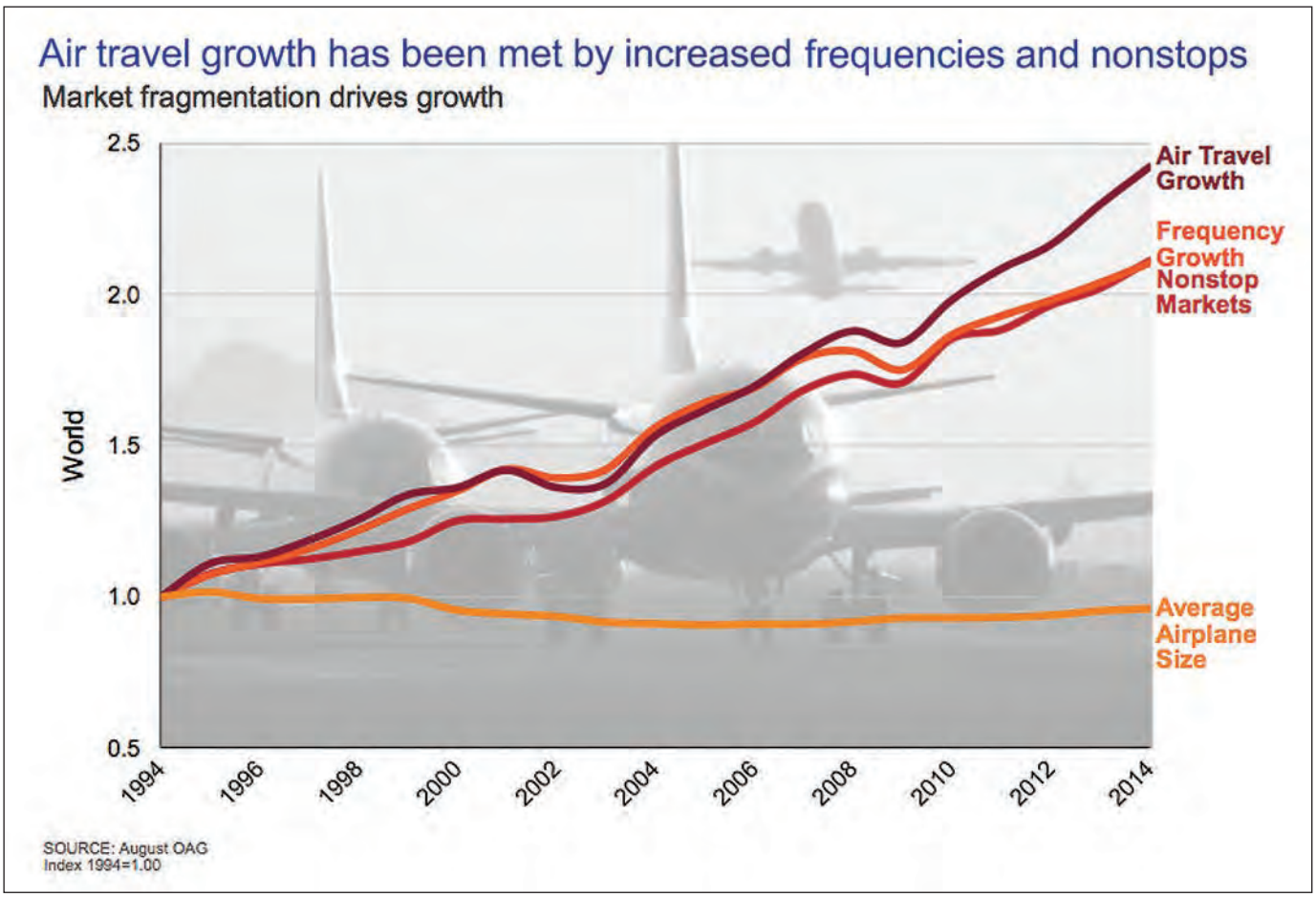


Airplane reliability affecting maintenance

As newer-generation airplanes become more prevalent in worldwide aviation fleets over the next 20 years, airplane reliability will improve, and maintenance-check intervals will lengthen. Although these advances will moderate demand somewhat, the global need for technicians will remain strong. Global fleet growth—along with an increasing trend in outsourcing maintenance, repair, and overhaul activities to third-party providers in emerging markets—will drive an increased need for qualified technicians sourced from more locations. The future need for maintenance personnel is again largest in the Asia Pacific region, which will require 238,000 new technical personnel. Airlines in Europe will require 101,000; North America, 113,000; the Middle East, 66,000; Latin America, 47,000; and the CIS and Africa, 22,000 each.

Fleet Development

In 2014, there were approximately 21,600 airplanes in service, a number that is expected to double over the next 20 years to an in-service fleet of 43,560 airplanes. To achieve that number, 38,050 new airplanes will be needed, and 26,730 of them, or 70 percent, will be single-aisle airplanes. Additionally, 8,830



new widebody airplanes will be needed. Regionally, the need for new airplanes is well balanced—Asia will need approximately 40 percent; Europe and North America combined will need approximately 40 percent; and together, the Middle East, Latin America, Africa, and CIS will need the remaining 26 percent.

Because aviation has been a growth business strongly tied to economic expansion and development, much of the demand focuses on industry growth requirements. But how are replacement dynamics evolving? Historically, two to four percent of the in-service fleet is removed from service annually. In the past few years, that number has been 500 to 700 airplanes per year, of which 350 to 400 were single aisle, and 150 to 200 were widebody, plus regional jets. Many factors can drive the need for replacement. Age is the primary one, but others include relative airplane economics, maintenance requirements, and the overall market environment. In recent years, high fuel costs have played a larger role in influencing decisions to remove airplanes from service, especially in the single-aisle category. On the other hand, the lack of availability of widebody airplanes has challenged airlines' ability to remove certain types from service as rapidly as desired. In 2015, however, a more favourable environment provided airlines with some near-term flexibility to manage aging fleets while growing capacity.

In the next 10 years, the number of single- aisle and widebody airplanes entering the zone of replacement will double. The number of single-aisle airplanes reaching 25 years of age has traditionally averaged 250 to 275 annually, but that figure will double to more than 500 by the beginning of the next decade. Meanwhile, the number of widebody airplanes reaching 25 years of age currently averages approximately 100 annually but will increase to well over 200 during the same period. These numbers are in addition to the more than 1,400 single-aisle, widebody, and freighter airplanes still in service after more than 25 years. To continue growing globally at the expected annual rate of nearly five percent, the airline industry needs an approximate net annual increase in fleet size of four percent, with approximately three percent replacement. Since fleet replacement is largely less optional than fleet growth, it provides a solid, stable base for long-term demand for new airplanes. The two largest fleet domiciles, Europe and North America, are expected to need well over 50 percent of their new deliveries to replace older, less efficient airplanes, as are the mature Northeast Asia and Oceania regions, thereby balancing the growth across emerging and developing markets in Asia, Latin America, and Africa.

Our long-term view of market demand is that airplane replacement will form 42 percent—a figure that has increased nearly every year as more fleets in emerging markets launch replacement cycles in the 20-year timeframe.

(To read Boeing's Current Market Outlook in its entirety, visit www.boeing.com/cmo) ■

All Present Not Accounted For

Weight is the ultimate numbers game in the air transport business. An incident in the Canadian north drives home the point.

On August 19, 2013, Buffalo Airways Ltd. Douglas DC-3C C-GWIR was operating as a scheduled passenger flight from Yellowknife, Northwest Territories, to Hay River, Northwest Territories. After lift-off from Runway 16 at 1708 Mountain Daylight Time, there was a fire in the right engine. The crew performed an emergency engine shutdown and made a low-altitude right turn towards Runway 10. The aircraft struck a stand of trees southwest of the threshold of Runway 10 and touched down south of the runway with the landing gear retracted.

An evacuation was accomplished and there were no injuries to the three crew members or the 21 passengers. There was no post-impact fire and the 406 MHz emergency locator transmitter did not activate.

History of the flight

Buffalo Airways Ltd. (Buffalo Airways) has a walk-in / on-demand system whereby passengers can arrive to board a plane without having to pre-book a seat on the flight. If the passenger/cargo load exceeds the capacity of one aircraft, an additional aircraft can be dispatched. On August 19, 2013, another DC-3C (DC-3) for the flight from Yellowknife, Northwest Territories (CYZF), to Hay River, Northwest Territories (CYHY), supplemented the occurrence flight, Buffalo 168 (BFL168). Prior to departure, BFL168 was loaded with cargo and 17 passengers at the Buffalo Airways hangar. Passengers were processed through the Buffalo Airways terminal, where they checked in and dropped off their checked luggage. Passengers and their baggage were not weighed at the check-in counter. After the aircraft had been loaded, four last-minute passengers were boarded along with their luggage. At the time of departure, the operational flight plan (OFP) was partially completed and did not reflect the number of passengers on board or the weight of the cargo. The crew did not receive a cargo manifest prior to departure.

At 1708, BFL168 received take-off clearance from the Yellowknife tower controller and initiated the take-off run from Runway 16 at the intersection of Runways 16/34 and 10/28. The runway distance available from the intersection was approximately 5,956 feet. At 1710, the tower controller observed heavy torching and smoke from the right engine and called to advise BFL168 of this observation. The tower controller received no response from BFL168. The crew of BFL168 was in the process of retracting the landing gear when a fire was observed in the right engine. An emergency engine shut down

was performed, which included feathering the right propeller. As the right propeller was moving towards a feathered condition, it stopped feathering before reaching the full feathered position and returned to windmilling. BFL168 made a low-altitude right turn in an attempt to reach Runway 10. The maximum height achieved by BFL168 was approximately 180 feet above ground level (agl).

While manoeuvring, BFL168 struck a stand of trees, about 30 feet in height, 690 feet southwest from the threshold of Runway 10. The initial point of ground contact was 400 feet beyond the trees. BFL168's wreckage trail was parallel to and south of Runway 10 and was about 330 feet in length. The landing gear and the flaps were in the retracted position. Due to the relatively low-energy impact, the emergency locator transmitter (ELT) did not activate.

Airport rescue and fire-fighting (ARFF) personnel were positioned south of Runway 10 due to an unrelated ground vehicle recovery operation. The tower controller directed ARFF to the occurrence site at approximately 1718. Once the aircraft came to a complete stop, the flight attendant initiated the evacuation of the 21 passengers through the left-aft door. The flight attendant returned to the aircraft and moved some galley drawers that were blocking the cockpit, and confirmed that the flight crew was safe. The three crew members subsequently evacuated the aircraft. ARFF sprayed the aircraft with fire retardant foam as a precaution. The crew and passengers, none of whom were injured, remained at the site under the supervision of ARFF for approximately 60 minutes, and were transported back to the Buffalo Airways terminal building.

Weather

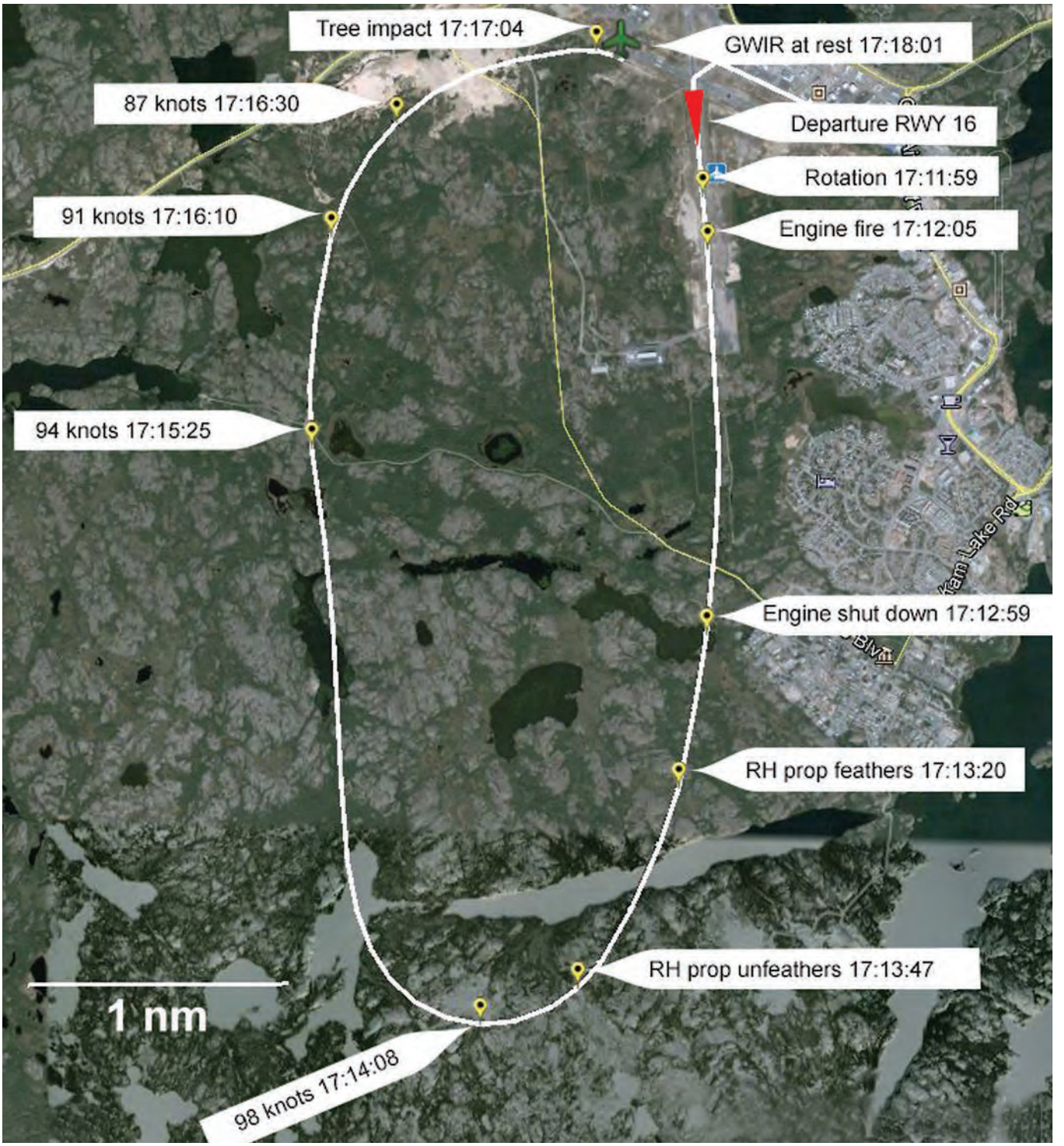
The aviation routine weather report (METAR) for Yellowknife at 1700 was wind 230° true (T) at five knots, visibility 15 statute miles (sm) with showers in the vicinity of the airport, few clouds at 1,000 feet agl, scattered cloud at 4,000 feet agl (with associated cumulonimbus), broken clouds at 15,000 and 24,000 feet agl, temperature 17°C, dewpoint 13°C, and the altimeter setting was 29.28 inches of mercury. The elevation of the Yellowknife Airport is 675 feet above sea level. The calculated density altitude was 1800 feet.

Flight crew and cabin crew

Records indicate that the flight crew was certified and qualified for the flight in accordance with existing regulations. The captain held a valid airline transport pilot licence and, during the occurrence, occupied the left seat as pilot flying (PF). The captain had accumulated approximately 13,000 hours of flight time, of which 4,300 hours were on the DC-3. There was no indication that fatigue was a factor in this occurrence. The crew was on a schedule that provided the required rest and time away from duties.

Aircraft

The aircraft was originally delivered as a military transport C-47B (Dakota) manufactured in 1942, serial number 42-23509. The conversion from military designation to civil required modifications as outlined in FAA Type Certificate Aircraft Specification No. A669. These modifications were performed



in February 1975 by Field Aviation Ltd., designating it as a DC-3C-S1C3G, serial number 9371. Two flight crew members are required to operate the aircraft, which was not equipped with a flight data recorder or a cockpit voice recorder, nor were these required by regulation.

Weight and balance

The aircraft has a maximum certified take-off weight (MC-TOW) of 26,200 pounds in the passenger configuration. On the day of the occurrence, the aircraft was configured for 28 passengers, which is the maximum allowed. In addition to the two crew members in the cockpit, there were 21 passengers and one flight attendant in the main cabin. Additionally, the flight was loaded with cargo. Departure fuel was listed as 2,707 pounds, which equates to 1,702 litres.

The OFP has a weight and balance section. The calculation for the flight had been started by the FO, but not completed prior to departure. It was common practice to complete the OFP and weight and balance enroute. The OFP reflected a crew of two, weight of 400 pounds, passenger seats weight

of 546 pounds and the departure fuel load of 2,707 pounds. Data from the incomplete OFP indicated a take-off weight of 21, 844.2 pounds. An actual take-off weight was not determined. The passenger manifest did not include the weights of the passengers or of their carry-on baggage. Passengers and their luggage were not weighed when they checked in, which was in contravention of company procedures. A separate cargo manifest, which was not available to the crew of BFL168, indicated a cargo weight of 1,071 pounds. Using the applicable standard passenger weights as prescribed by the Company Operations Manual (COM), the data from the OFP and the actual cargo weight, the operational take-off weight for the occurrence flight was determined to have been 27,435 pounds, 1235 pounds over the MCTOW. The centre of gravity of 25 percent of mean aerodynamic chord (MAC) was within the limits prescribed by the manufacturer.

Aircraft performance

The minimum climb speed at maximum except take-off (METO) power at 26,200 pounds should not be lower than 90 knots indicated airspeed (KIAS). The DC-3 aircraft flight manual (AFM) indicates that with one engine inoperative and METO power or less on the operative engine, the minimum control speed – air (VMCA) is 73 KIAS. At the take-off power setting, VMCA will be 76 KIAS.

According to the AFM single-engine climb performance chart, the DC-3 at the MCTOW of 26,200 pounds with the inoperative engine feathered, landing gear and flaps in the retracted position, should be able to achieve a rate of climb of 330 feet per minute (fpm). The performance charts do not differentiate between whether it is the critical engine or non-critical engine that is inoperative. If the engine were idling under the same configuration, a single-engine rate of climb of 210 fpm could be achieved.

Engine and propeller examination

The Pratt and Whitney R1830-92 Twin Wasp 14-cylinder radial engine was air-cooled and had a single-speed supercharged induction system. The 14 cylinders were each composed of two main parts, a barrel and a head. The cylinder barrel was forged from steel alloy and included a flange for attachment to the crankcase and an externally threaded portion for mating with the head. C-GWIR right engine number one cylinder head and barrel were found separated due to a fracture of the barrel at the threaded joint with the head assembly. The cylinder head, barrel and piston were forwarded to the TSB laboratory for examination. A pre-existing fatigue crack was discovered in a thread groove on the outer mating surface of the barrel assembly. The cause of the fatigue crack could not be determined due to post-separation damage in the area of the point of origin.

The time between overhaul (TBO) cycles for the R1830-92 was 1,400 hours; the occurrence engine had accumulated 98.7 hours since overhaul at the time of the failure of the number one cylinder assembly. The overhaul inspection of the cylinder assembly consisted of visual and dimensional checks followed by non-destructive test (NDT) inspection. Dye penetrant or Magnaflux methods are used for the detection of cracks in the

barrel or head components. The overhaul inspections determine if the assembly will remain in service or will be scrapped. Company experience with these overhauled cylinders was to expect three to four cylinder failures per overhaul cycle. Most defects were discovered by maintenance inspections and pressure tests.

In the event of an engine failure or shut down on a multi-engine aircraft, feathering the propeller of the inoperative engine is critical to minimize the drag induced during flight. The DC-3 propeller feathering system provides a method to move the propeller blades to 88-degree pitch angle, which stops the rotation (windmilling) of the propeller. The system consists of an oil pump driven by an electric motor, which supplies pressure oil to the propeller dome via the propeller governor. A feathering button (located in the cockpit) energizes the pump, and pressure oil is applied to the aft side of a piston in the pitch change mechanism, which drives the blades towards feather. An electrical latch is created and controlled by the propeller governor pressure-sensitive cut-out switch assembly, which energizes a solenoid holding the button in. When the piston reaches its maximum stop (i.e., full feather position), the pressure increases to above 600 pounds per square inch (psi) where the cut-out switch releases the latch, de-energizing the solenoid, which releases the button and removes power from the pump motor. This completes the feathering cycle. If the trip pressure of 600 psi is not reached, the pump continues to run until it fails. There is no back-up pump. A failure of the pump motor before full feather blade angle is achieved will result in the propeller blades moving towards fine pitch due to the centrifugal force of the rotating propeller and pitch change mechanism spring tension. Oil pressure is required to overcome these forces. There are no visual indications to warn the flight crew of pump operation. Monitoring the propeller rotation and the feathering button position are the only procedures to ensure proper operation has occurred.

The feathering system is also designed to unfeather the propeller. In normal procedures, a propeller may be unfeathered by holding the feathering button in. The propeller governor pressure-sensitive cut-out switch is overridden, enabling the pump pressure to rise above the pre-set dome distributor valve setting, which shuttles oil pressure to the opposite side of the piston in the pitch change mechanism and drives the blades towards fine pitch. In flight, this would cause the propeller to rotate due to airflow assisting in a restart procedure.

On the flight, the engine was shut down and the propeller feathering system activated. The propeller rotation slowed, but the propeller was then observed windmilling for the remainder of the flight. Impact marks on the bevel gears of the pitch change mechanism and rotating cam stop position indicate approximately 46-degree blade pitch angle at impact. The design of the propeller pitch change mechanism allows for normal constant speed blade angle operation between 18 and 48 degrees. Feathering system pressure is required to overcome mechanical resistance above 49 degrees to prevent inadvertent propeller feathering. Feathering system components were inspected and an anomaly was found in the electric pump motor. Subsequent system tests indicated that the motor was not operational post impact. The motor, pump, propeller governor, and associated relay were removed and sent to the TSB laboratory for analysis. Some system component failures will result in the pump continuing to run and cycling the propeller blade angle through feather and back towards fine pitch. The excessive and changing drag status of the aircraft with a windmilling propeller would make it difficult to control the aircraft.

Findings as to causes and contributing factors

An accurate take-off weight and balance calculation was not completed prior to departure, resulting in an aircraft weight that exceeded its maximum certified take-off weight. The right engine number one cylinder failed during the take-off sequence due to a pre-existing fatigue crack, resulting in an engine fire. After the right propeller's feathering mechanism was activated, the propeller never achieved a fully feathered condition likely due to a seized bearing in the feathering pump. The windmilling right propeller caused an increase in drag which, combined with the overweight condition, contributed to the aircraft's inability to maintain altitude, and the aircraft collided with terrain short of the runway. The operator's safety management system was ineffective at identifying and correcting unsafe operating practices. Transport Canada's surveillance activities did not identify the operator's unsafe operating practices related to weight and balance and net take-off flight path calculations. Consequently, these unsafe practices persisted.

Safety action taken

Buffalo Airways has begun to enforce the practice of weighing individual passengers and baggage in order to calculate a weight and balance prior to departure. The company has also contracted the development of net take-off flight path charts for its flights. On February 25, 2015, Transport Canada approved a revised Company Operations Manual for Buffalo Airways. As a result of this occurrence, the company made the following changes: complete revision and re-issuance of a new Company Operations Manual; structural re-organization of the roles and responsibilities of management personnel; the safety management system (SMS) manager now has a reporting line direct to the accountable executive; and the appointment of new staff, including a new accountable executive, a new operations manager assistant, and a new director of maintenance. Additionally, Buffalo Airways has completed re-training of the operations manager; hiring of an operations consultant to assist with regulatory compliance; re-alignment of the operations manager's responsibilities to identify and address more effectively non-compliance with regulatory requirements; and development of policies and procedures by the accountable executive and the operations manager to ensure regulatory compliance.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on April 22, 2015. It was officially released on April 27, 2015. ■

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American helicopter market: Increasing focus on flexible MRO solutions

A busy market creates its own problems. Could be a good thing.

Year 2015 was without a doubt a roller coaster ride for the rotorcraft industry. Despite the added turbulence, though, the demand in the market remained steady. According to Honeywell, up to 5,250 new machines are forecasted to hit the market in the upcoming four years. The majority (53 percent) of these helicopters will supplement the Western Hemisphere, where the increasing number of aircraft is putting immense pressure on MROs.

Operators in Latin and North Americas continue to lead the global purchase plans and expect to increase their helicopter use by 45 and 27 percent respectively. However, what burdens the life of MROs working in the area is the diversity of the market. Different manufacturers are constantly expanding their product portfolios in the region and continue to see great potential in both markets, thus challenging local maintenance facilities to keep up with the diversification.

"It's a constant battle and there's never going to be a winner. Independent MROs are left to scan and analyze the market in search of opportunities that OEMs may not see or are unable to handle," says Anatolij Legenzov, the CEO of Helisota. "For instance, Airbus Helicopters and Bell Helicopters have more than 60 years of experience working in South America. And yet, the region is not a number one priority for Bell Helicopters as it represents only 13 percent of the total bookings for this European manufacturer. Therefore, it comes to no surprise that the focus on these particular markets is not as intense as stated and there are still certain unaddressed needs and demands in the region."

When the market is as diverse as it gets, operators tend to seek different options with regard to maintaining the airworthiness of theirs fleet with the aim to facilitate smoother maintenance processes. While the aforementioned manufacturers manage multiple support bases throughout the world, other manufacturers including Russian Helicopters with more than 400 units flying in the region and AugustaWestland with a fleet of over 200 helicopters are growing their helicopter numbers without strong maintenance support network.

On top of that, Russian-produced rotorcraft are the frontrunners in the segment of commercial helicopters with the maximum take-off weight of 10-12 tons, accounting for 77 percent of the regional fleet. Moreover, they account for up to 42 percent of all military helicopters across Latin America. "Inevitably, due to their universal use, Russian-built machines will conquer an even bigger part of the regional market meaning that the know-how of their maintenance and a developed spare parts supply network will be a highly valued asset of any maintenance facility," says Legenzov.

Naturally, every brand and manufacturer is on the hunt for a bigger market share, and it is clearly making life for MROs in the region more complex. Trying to increase the availability of technical support services, Russian Helicopters, AugustaWestland and several other players are planning technical support bases for their production.

"Customers always seek flexibility," says Legenzov. [They want] services that can be tailor-made for each and every specific need, despite the make or origin. And when they manage to build a strong relationship with partner holding vast experience as well as strong in-house capabilities, operators of the Americas tend to hold on to that." ■

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