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AirMaintenance UPDATE

The Magazine for Aircraft Maintenance Professionals

Winglet technologies: saving fuel and costs

Winterizing: a checklist

PAMA and AME news

Transport Canada Approved for R/T

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Pure speed is the assignment

GE Aviation debuts Affinity, first civil supersonic engine in 55 years.

GE Aviation is helping to launch a new era of efficient supersonic flight with Affinity, which will power the Aerion AS2 supersonic business jet's first flight in 2023. Engineers have completed the initial design of the first supersonic engine purpose-built for business jets. GE's Affinity turbofan engine class integrates military supersonic experience, and advanced business jet engine technologies.

"Our mission is to enhance global mobility with supersonic speed, starting with business aviation, and following with successively faster and larger designs for business and commercial aviation," says Aerion CEO Tom Vice. "GE Aviation is making this new efficient, sustainable supersonic era possible through its pioneering work on the Affinity engine."

GE's Affinity is a new class of medium bypass ratio engine, a twin-shaft, twin-fan turbofan designed for supersonic flight over water and subsonic flight over land without requiring modifications to existing compliance regulations. Its features include a high-altitude service ceiling of 60,000 feet and an engine core adapted from GE's commercial airline portfolio with billions of hours of operational service.

Aerion is collaborating with GE Aviation, Lockheed Martin, and Honeywell to develop the AS2, which is targeted for certification in 2025. As much as 60 percent faster than today's civil jets while clipping along at 1,000 mph, this 12-passenger jet will reportedly save travelers as much as three hours across the Atlantic and five hours across the Pacific.

Pure speed was the primary goal of this project, say officials.

"In the last 50 years, business aircraft speeds have increased by less than 10 percent," affirms Brad Mottier, GE vice president and general manager for Business and General Aviation & Integrated Services. "Instead of going faster, cabins have increased in size and become more comfortable — and range has become longer. With large, comfortable cabin, long range aircraft in the marketplace, the next step is speed… made possible with GE's Affinity." ■

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art director: Cliff Vickstrom
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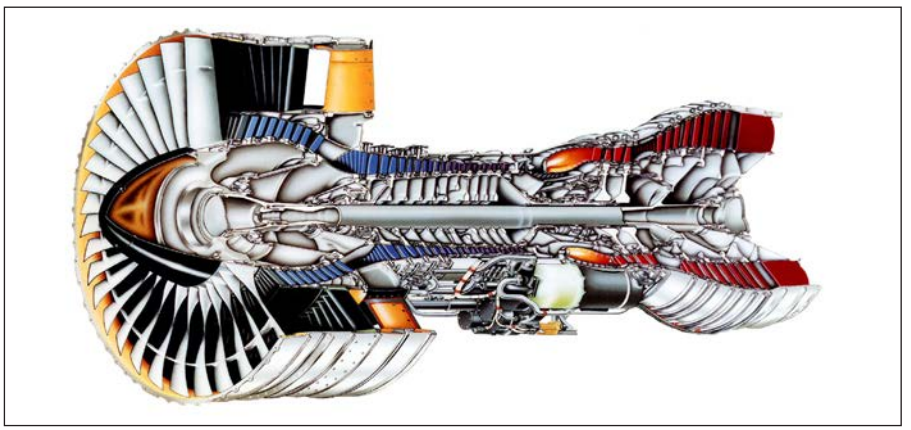
Upcoming Events

PW4000 engine fires prompt proposed engine checks



The Federal Aviation Administration is preparing to require airlines to inspect fuel nozzles on some Pratt & Whitney PW4000 engines in response to several engine fires. The agency has written two proposed rules addressing the risk, including one that would require engines be inspected before further flights.

The proposals mark the FAA's response to reports of fuel nozzle manifold cracks in some PW4000 engines, and to several instances of fuel leaks and PW4000 engine fires. The rule targets several PW4000 variants that power Airbus A300s, A330-200s and A330-300s, according to Flight Fleets Analyzer.

It applies to 186 engines in service with US airlines, though some 600 such engines are in service worldwide, Fleets Analyzer shows. American Airlines, Delta Air Lines, FedEx and UPS Airlines operate PW4000 variants named by the FAA.

"This [directive] was prompted by several reports of high cycle fatigue cracks in the fuel nozzle supply manifold," says one of two proposed rules. "Thermal mechanical fatigue due to high thermal gradients" caused the cracks, it adds. "This condition, if not addressed, could result in engine fire, damage to the engine, and damage to the airplane."

Inspections and parts replacement could cost airlines about $500,000 per engine, the FAA estimates. The agency is accepting comments from industry for 45 days.

The documents do not describe the specific events that prompted the proposed rule. But earlier this year Nigerian investigators said they were looking at fuel nozzle leaks as a possible factor related to a PW4000 engine fire. That fire happened on a Delta A330-200 taking off from Lagos in March.

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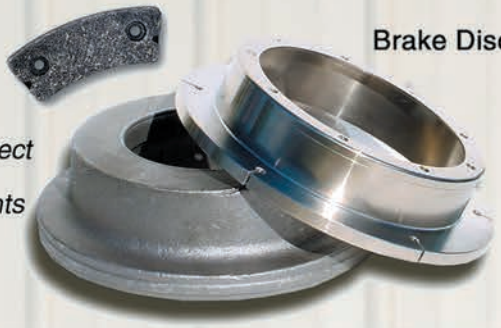

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STCs & new products

New system tests starter/generator units

SAKOR Technologies has a new system for the testing of aircraft starter/generator units (SGUs). Included in the system is an AccuDyne AC dynamometer automated by the DynoLAB test cell control system. The test stand also includes a high-precision power analyzer and a separate three-phase regenerative inverter, which enables testing of the SGU without requiring an aircraft electronics panel be used. The 18-kW dynamometer can operate at up to 14,000 rpm. This dynamometer, along with the inverter provided by SAKOR, tests new starter/generator products in both starter and generator mode. **For information visit** www.sakor.com

Safety eyewear features anti-scratch performance

Maverick Eye Protection, the first eyewear created for the KleenGuard Brand, was an award winner in the "Best in Show" New Product Showcase at the 2018 National Safety Council (NSC) Congress & Expo. Features include anti-glare coating to reduce eyestrain and fatigue, anti-fog and anti-scratch performance, and comfort touch points to prevent slippage and reduce pressure. Maverick Eye Protection can be diverted from landfills through The RightCycle Program, the first large-scale recycling program for non-hazardous lab, cleanroom and industrial waste. The RightCycle Program turns used apparel, gloves and protective eyewear into new consumer goods. **For information visit** www.KCProfessional.com

Kadex Aero now distributes Tanis preheat systems

Established in 1974, Tanis Aircraft Products is a manufacturer of aircraft engine preheat systems, and was the first to develop aircraft engine preheat systems for piston engines, helicopter preheat, and turbine preheat; and was the first company to meet the requirements for FAA STC. Pre-heating your aircraft is essential when the engine has been allowed to drop to temperatures below -10F/-12C, and is recommended when the outside air temperature is below 50F/10C. Tanis preheat systems thoroughly heat-soak the engine, which reduces the chance of frost on spark plugs, and condenses start-up time. This saves fuel, as well as wear and tear on your engine.

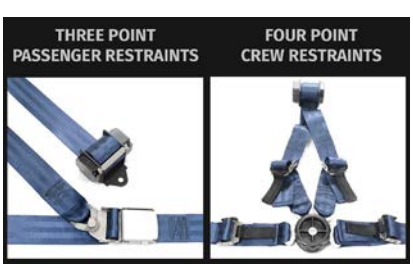
For more information visit www.kadexaero.com

Tool shadow kits eliminate wasted time

Visual Workplace, Inc. has introduced do-it-yourself foam tool shadow kits. The shadow boards keep tools and work areas organized, eliminating wasted time spent searching for tools. The two-piece, closed-cell foam kits offer three contrasting colour combinations so operators can quickly visually identify when tools are not in their proper place. The foam organizers can easily be placed in drawers or racks. Tool organizers can also be easily customized to create the most organized and efficient work area possible.

For information visit www.visualworkplaceinc.com

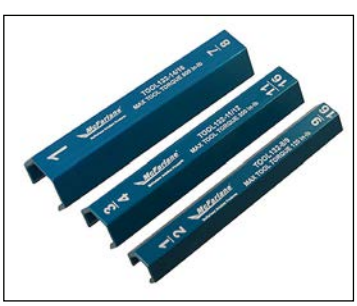
Aircraft restraints are hand-inspected



Aircraft Belts, Inc. is now offering complete OEM substitute four-point crew and three-point passenger restraints for the King Air 350 and 350i series aircraft. The ABI restraints, which are TSO-approved, are custom-designed (lengths, colour, fittings and hardware) to fit specific aircraft needs. Each restraint is certified to FAA TSO C22 (g) and C114, following FAA procedures and standards.

For more information visit www.aircraftbelts.com

Precision tools reduce fatigue



McFarlane offers a wide-range of affordable, precision tools for aircraft maintenance, including a longer vacuum pump wrench, complete control wrench set, and enhancement of the elevator rigging tool.

McFarlane's wheel and prop balancer now features an expanded line of bushings. McFarlane tools reduce fatigue while increasing accuracy of the work.

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BOMBARDIER CRJ SERIES CERTIFIED FOR HIGHER MAINTENANCE INTERVALS

The Federal Aviation Agency (FAA) has granted approval for the maintenance intervals escalation of Bombardier's CRJ700, CRJ900 and CRJ1000 aircraft. The line maintenance interval (A-check) is extended to 800 flight hours, and the heavy maintenance interval (C-check) at 8,000 flight hours.

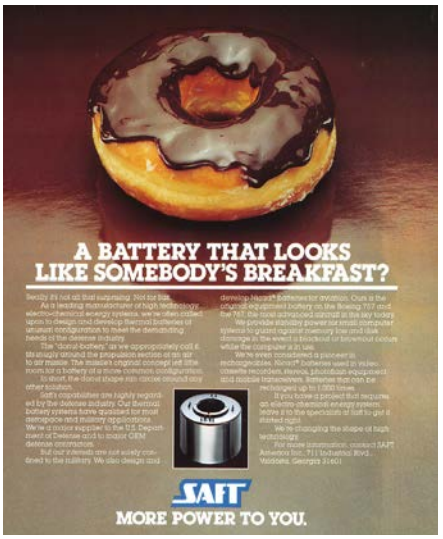
"... the CRJ Series operators can now take advantage of 14 percent less maintenance days, meaning more days of revenue flying," said Charles Comtois, Head of CRJ Series Program, Bombardier Commercial Aircraft.

The maintenance intervals have doubled since the launch of the CRJ aircraft family. The new maintenance intervals are applicable for new production deliveries as well as all CRJ700, CRJ900, and CRJ1000 aircraft in service.

SAFT CELEBRATES 100-YEAR ANNIVERSARY

This fall French industrial battery manufacturer Saft celebrated its place on an exclusive list of technology companies that have existed for a century or more. To mark the occasion the company hosted an anniversary reception during the month of October at the National Business Aviation Administration convention in Orlando, Florida.

Founded in 1918, Saft made its name providing highly specialized batteries for uses from transportation to energy storage and from space exploration to the Internet of Things. More than 3,000 customers worldwide rely on Saft batteries for their long life and ability to function in the most extreme conditions.



Today, Saft employs 4,300 people in 18 countries. The company has research centers in France and the US, where it has a particularly strong footprint, and 14 manufacturing sites and 30 sales subsidiaries across the world.

P&WC DELIVERS FIRST BATCH OF SAR ENGINES

Pratt & Whitney Canada recently started delivering PW127G engines to Airbus Defence and Space in support of Canada's Fixed-Wing Search and Rescue Aircraft Replacement Project. The engines will be installed on specially configured Airbus C295 aircraft, which will be designated the CC-295 in Canada. The Canadian Department of National Defence (DND) is scheduled to receive the first of 16 CC-295 aircraft by the end of 2019. The DND intends to replace its existing search and rescue (SAR) fixed-wing aircraft with the CC-295.

Pratt & Whitney Canada has delivered more than 400 PW127G engines to Airbus Defence and Space for numerous C295 customers and variants. The PW100 engine family powers several aircraft families around the world, performing a variety of missions in diverse climates and flying conditions. The engine family consists of 38 engine models. With more than 9,500 engines delivered to date, the family has accumulated 190 million engine flight hours.

AIRBUS WILL DELIVER TO CALGARY STARS AMBULANCE

Airbus has announced that its H145 was selected as the fleet replacement aircraft for STARS air ambulance's aging fleet, becoming the first H145s in HEMS configuration to enter Canada. The twin-engine H145 with HEMS interior will support STARS' highly specialized emergency medical transport for the critically ill and injured, many of which are located in rural areas. The first H145s will be delivered in 2019 and will be based out of STARS' Calgary, Alberta base.

Airbus' H145 is Transport Canada Civil Aviation (TCCA) certified and is the latest member of its four-ton-class twin-engine rotorcraft product range. To date, the global H145 fleet has achieved more than 100,000 flight hours since entry into service in 2015, with more than 200 units delivered.

The helicopter is easily customized for intensive care transport, due to its easy and safe loading/unloading of patients through wide side sliding doors and large rear clamshell doors. The H145's cabin provides full body access and greater comfort for the medical

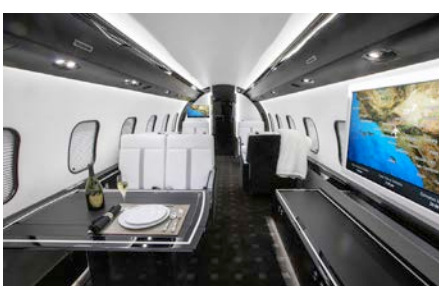
crew, and low external sound levels allow neighbourhood-friendly operations around hospitals and in urban areas.

GLOBAL 7500 AWARDED TC-TYPE CERTIFICATION

Bombardier Business Aircraft's Global 7500 aircraft, the largest, most luxurious and longest range business jet ever built, has been awarded Transport Canada Type Certification, paving the way for entry-into-service this year. Certification by the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) is expected to follow shortly. The Global 7500 aircraft has accumulated more than 2,700 flight hours since the flight-testing program began in November 2016.

The aircraft has an unmatched range of 7,700 nautical miles, a full 300 nautical miles further than initial commitments, and it is the only business aircraft that can connect New York to Hong Kong, and Singapore to San Francisco, nonstop. With its four living spaces, the Global 7500's numerous creature comfort features include a modern and multi-functional kitchen.

GLITZY GLOBAL ONE ARRIVES ON CHAMPAGNE CIRCUIT



Jet Edge International recently added a completely customized Bombardier Global Express dubbed 'Global One' to its world-class charter fleet. With flights from Los Angeles to London starting at $200,000, the Global One features a 12-passenger cabin with hand-stitched leather seats, handmade cabinetry, and stainless-steel trim throughout. Cabin atmosphere and overall mood can be tailored to the personal preferences of fliers with a colour-changing LED lighting system.

Global One sleeps up to six passengers on five convertible berths. The aircraft also features an aft-cabin private stateroom that can be configured with either king or full-size berthing divans. Ultra-premium wine and spirits are available on each Global One flight, with a cabin complete with designer furnishings and 24/7 concierge service.

HARTZELL PROPS TO DRIVE ELECTRIC COMMUTER

Eviation Aircraft has selected Hartzell Propeller as a development partner for Eviation's debut aircraft, the all-electric Alice. With zero-emissions and 100 percent battery-electric solution, the Alice Aircraft will be test flown at the 53rd Paris Air Show in June 2019.

Under the terms of the development partnership, Hartzell Propeller will provide an innovative system of new propellers, designed to meet the unique needs of the first-in-kind aircraft. Each of the propellers in the three-unit ship set will be approximately 65 inches in diameter and feature carbon fibre blades with nickel cobalt leading edges, certified for unlimited life.

FIRST BOEING 777X FLIGHT TEST COMES TOGETHER

Boeing has brought together the major fuselage sections to form the first 777X that will take to the skies in 2019. In a major production milestone called 'final body join,' Boeing teams connected the airplane's nose, mid and aft sections in the company's factory in Everett, Washington. The jet now measures 252 feet long (77 meters) from nose to tail, making it the longest passenger jet the manufacturer has ever produced.

With the extension of a set of folding, raked wingtips, the airplane's wing spans 235 feet (72 meters). The first 777X introduced will be the 777-9 model, which can seat 400 to 425 passengers in a standard configuration and offer a range of 7,600 nautical miles (14,075 km).

The first 777X test airplane for static ground testing was completed in September 2018. Three additional flight test airplanes will be built after flight test #1. The 777X first flight is scheduled for 2019, with delivery slated for 2020. ■

Innovations in winglets:

After 20 years as standard equipment for many aircraft, the economic and environmental benefits of blended winglet technology are now being fully realized.

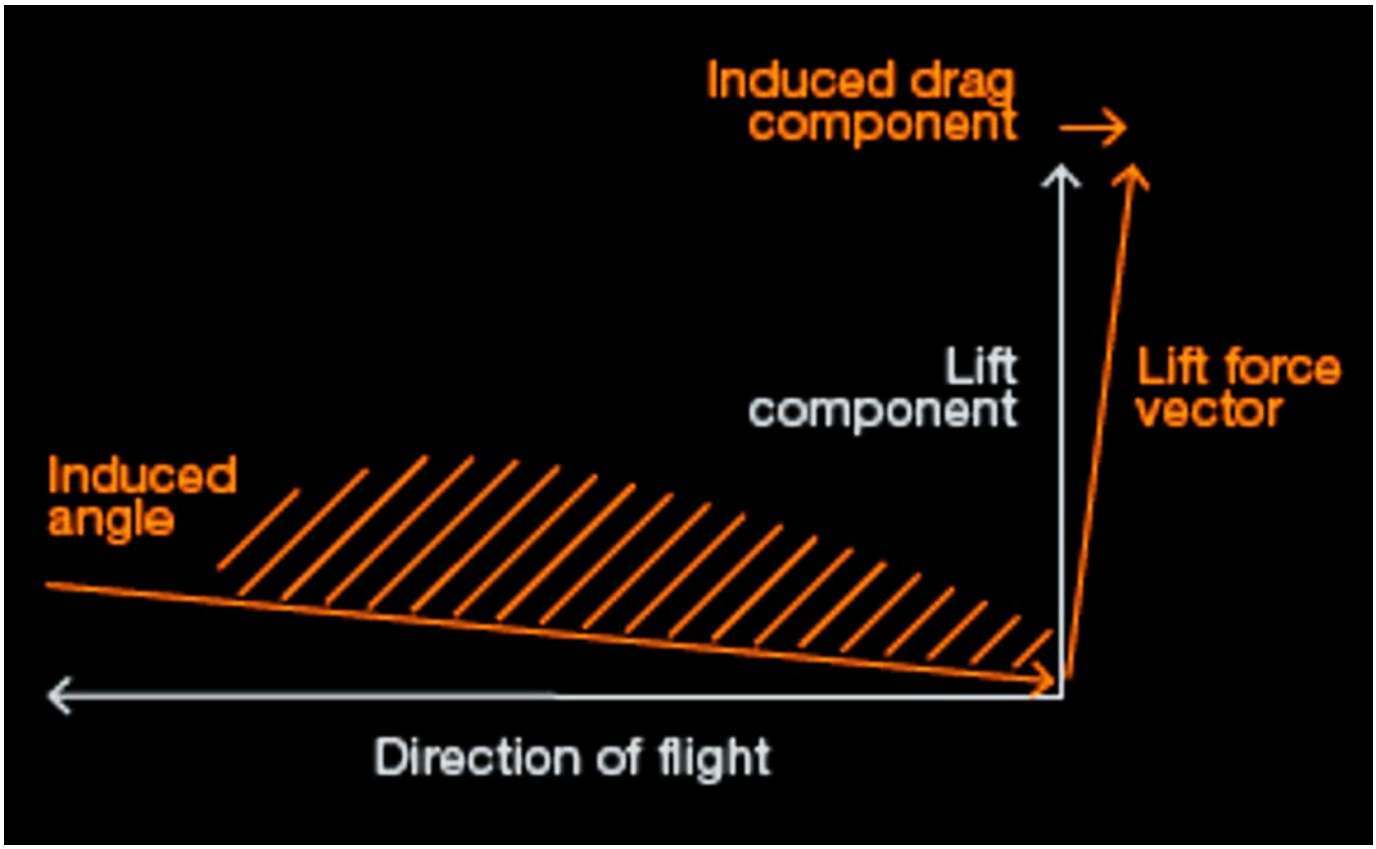
Opposite Page: Billions of gallons of fuel have been saved thanks to this graceful geometry. Above: Split scimitar winglets are now standard on all new Boeing Business Jet aircraft including this MAX 7.

reducing CO_2 emissions

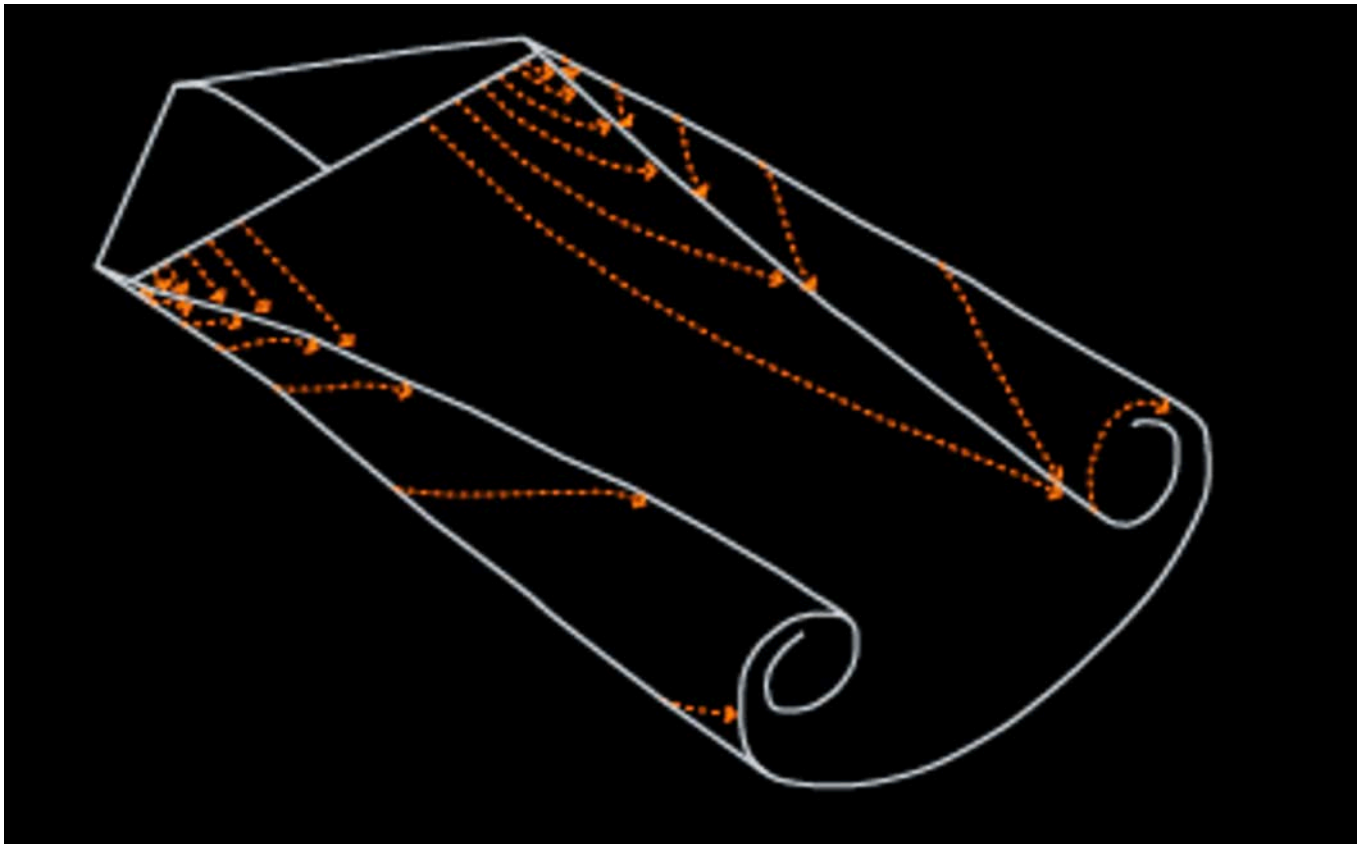
Early in November, Aviation Partners, Inc. (API) and Aviation Partners Boeing (APB) reported that in the past two decades their blended winglet and split scimitar winglet technologies have saved the world's commercial and business jet operators an estimated nine billion gallons of jet fuel, resulting in a corresponding global reduction of over 95 million tons of carbon dioxide (CO2) emissions. The degree of success of the innovation seems to surprise even the companies' executives.

"We look back over the past 20 years with amazement on how our idea to mitigate a trans-continental business jet fuel stop has utterly transformed the shape of global aviation," said Joe Clark, founder and chief executive officer of API, and chairman of APB. The partner groups go on to say they expect the cumulative fuel savings from their technology to exceed 10 billion gallons in September of 2019.

Also in November, the US Global Change Research Program went public with its Fourth National Climate Assessment (NCA4) report following decades of environmental research by scientists from 13 federal agencies. The news wasn't good. But two decades after development, the enviro-benefits of the blended winglet are finally being fully realized



Above: Blended winglets affect induced drag.



Below: The vortex wake behind a lifting wing.

and now is an opportune time to revisit the device and see how it actually works.

Essentially, blended winglets improve airplane performance by reducing drag. APB began making them available on the Boeing Business Jet (BBJ) and Next-Generation 737-800 in 2001, and they have now been installed on over 8,500 aircraft. Flight test data has demonstrated that blended winglets lower block fuel and CO2 emissions by up to four percent on the 737 and up to five percent on the 757 and 767. For the 767, saving half a million U.S. gallons of jet fuel a year per airplane translates into an annual reduction of more than 4,790 tonnes of CO2.

More than 2,850 Boeing airplanes have been equipped with blended winglets, which were initially investigated by Boeing in the mid-1980s and further developed in the early 1990s by API, a Seattle, Washington corporation of aerospace professionals consisting primarily of aeronautical engineers and flight test department directors.

The blended winglet provides a transition region between the outboard wing, which is typically designed for a plain tip, and the winglet. Without this transition region, the outer wing would require aerodynamic redesign to allow for the interference between the wing and winglet surfaces.

The first blended winglets were installed on Gulfstream II airplanes. The resulting improvements in range and fuel efficiency interested Boeing, and in 1999, Boeing formed the joint venture company APB with Aviation Partners, Inc., to develop blended winglets for Boeing airplanes.

MODEL	LOAD (PASSENGERS)	MISSION (NAUTICAL MILES)	FUEL USE WITHOUT WINGLETS (LBS)	FUEL USE WITH WINGLETS (LBS)	ESTIMATED FUEL SAVINGS
737-800	162	500	7,499	7,316	2.5%
		1,000	13,386	12,911	3.5%
757-200	200	1,000	16,975	16,432	3.2%
767-300ER	218	3,000	65,288	62,419	4.4%

Blended winglet retrofit certification history

Blended winglets are available for retrofit through APB on the 737, 757, and 767 models.

AIRPLANE MODEL	BLENDED WINGLET RETROFIT CERTIFICATION DATE
737-300	May 2003
757-200	May 2005
737-500	May 2007
737-900	October 2007
767-300ER	March 2009
757-300	July 2009

Above: Estimated fuel savings on airplanes equipped with blended winglets. Left: Blended winglet retrofit certification history.

Boeing adopted the blended winglet technology as standard equipment for the BBJ in 2000 and APB certified the winglets for the 737-700 and 737-800 airplanes in 2001. Since then, APB has certified blended winglets for retrofit installation on other Boeing airplane models. Blended winglets are also installed in production on Next-Generation 737-700/-800/-900ER models.

The motivation behind all wingtip devices is to reduce induced drag. Induced drag is the part of the airplane drag due to global effects of generating lift. In general, wings will produce air motion, called circulation, as a result of generating lift. This motion is characterized by downward flow between the wingtips and upward flow outboard of the wingtips. As a result, the wing flies in a downdraft of its own making. The lift vector is thereby tilted slightly backward. It is this backward component of lift that is felt as induced drag.

The magnitude of the induced drag is determined by the spanwise lift distribution and the resulting distribution of vortices. The vortex cores that form are often referred to as "wingtip vortices," but the entire wingspan feeds the cores. Any significant reduction in induced drag requires a change in this global flow field to reduce the total kinetic energy. This can be accomplished by increasing the horizontal span of the lifting system or by introducing a nonplanar element that has a similar effect.

Blended winglets are upward-swept extensions to airplane wings. They fea-

ture a large radius and a smooth chord variation in the transition section. This feature sacrifices some of the potential induced drag reduction in return for less viscous drag and less need for tailoring the sections locally.

Although winglets installed by retrofit can require significant changes to the wing structure, they are a viable solution when gate limitations make it impractical to add to wingspan with a device such as a raked wingtip.

The drag reduction provided by blended winglets improves fuel efficiency and thereby reduces emissions. Depending on the airplane, its cargo, the airline's routes, and other factors, blended winglets can:

- Lower operating costs by reducing block fuel burn by four to five percent on missions near the airplane's design range.
- Increase the payload/range capability of the airplane instead of reducing the fuel consumption.

Photo right: Various aircraft winglet types.

Above: This Falcon 900 features a blended winglet, which has a large radius and is designed with a smooth chord variation in the transition area where the wing joins the winglet.

- Reduce engine maintenance costs.
- Improve takeoff performance and obstacle clearance, allowing airlines to derate engine thrust.
- Increase optimum cruise altitude capability.

Operators of blended winglets gain the additional environmentally friendly benefit of reducing engine emissions and community noise. CO2 emissions are reduced in direct proportion to fuel burn, so a five percent reduction in fuel burn will result in a five percent reduction in CO2. Nitrogen oxide (NOx) emissions are reduced in percentages that are a function of the airplane, engine, and combustor configuration.

At airports that charge landing fees based on an airplane's noise profile, blended winglets can save airlines money every time they land. The noise affected area on takeoff can be reduced by up to 6.5 percent. With requirements in many European airports for airplanes to meet Stage 4/Chapter 4 noise limits, the addition of blended winglets may result in lower landing fees if the winglet noise reduction drops the airplane into a lower-charging noise category. The noise reduction offered by blended winglets can also help prevent airport fines for violating monitored noise limits.

Airlines have been gathering operational data on blended winglets since they first began flying airplanes equipped with the modification in 2001. These benefits include:

- One operator flying 737-700s had three years of data showing a fuel savings of three percent.
- Another operator flying 737s also reported that blended winglets are helping reduce fuel consumption by three percent, or about 100,000 U.S. gallons of fuel a year, per airplane.
- Other airlines are projecting results based on historical flight data about airplane models recently equipped with blended winglets:
- An operator with a fleet of 767-300ER airplanes estimates that installing blended winglets saved 300,000 U.S. gallons of fuel per airplane per year, reducing CO2 emissions by more than 3,000 tonnes annually.
- An airline that recently began flying 767-300ERs with blended winglets anticipates that each airplane equipped with the winglets will save up to 500,000 U.S. gallons of fuel annually, depending on miles flown. The airline plans to install winglets on its entire 58-airplane fleet of 767-300ERs, which could result in a total savings of up to 29 million U.S. gallons of fuel per year and a reduction of up to 277,000 tonnes of CO2 emissions annually.

Blended winglets are a proven way to reduce drag, save fuel, cut CO2 and NOx emissions, and reduce community noise. They can also extend an airplane's range and enable additional payload capability depending on the operator's needs.

Depending on the airplane model, blended winglets are available either as standard or optional equipment through Boeing or for retrofit through Aviation Partners Boeing.

(With Aero files.) ■

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Time to Winterize:

The long hard days of winter are now upon us. Whether that aircraft you're responsible for maintaining is being stored for the season or scheduled for regular use in the cold, there are season-specific considerations to keep in mind. Reviewing the basics never hurts.

Opposite: De-icing aircraft. Another winter ritual. Above: Temperature changes cause expansion and contraction of metals, and adjustments may have to be made to compensate for these changes.

a seasonal checklist

With winter just around the corner and/or in full swing in some regions, many pilots and their technicians are now making cold-weather preparations. Most techs working in Canada or the northern United States already know the drill, but even the basics are worth repeating.

To begin with, there are different considerations when preparing an aircraft for winter depending on whether the owner/operator plans to operate the aircraft during the winter months or just store it. When preparing an aircraft for winter operation, the first step should be to refer to the applicable maintenance manuals. They will spell out specific maintenance and inspection items necessary for cold weather operation. Each aircraft has specific requirements, but here are a few general tips to keep in mind.

Check the heating system

Probably the most critical item to inspect in preparation for winter operation is the heating system. Many aircraft are equipped with cabin heater shrouds that enclose the muffler or portions of the exhaust system. It is important that the entire heater system be inspected to eliminate the possibility of carbon monoxide entering the cockpit or cabin area.

Above: DAIDS overhead panel. Engine anti-ice ON-OFF button.

Each year, accident investigations reveal that carbon monoxide has been a probable cause in accidents that have occurred in cold weather operations.

Even if the aircraft has a gas-powered heating system such as a Janitrol heater, you still need to ensure that the heater is in proper working order. Remember that proper heating system operation isn't just about pilot comfort; it's about safety.

Lubrication

Ensure the correct grade of engine oil is installed. In addition, make sure to use the recommended grade of lubricant to grease the aircraft. Oils and greases that are great for summer operation could have a detrimental effect in the wintertime. Always follow manufacturer recommendations for lubrication.

Oil system insulation

Some manufacturers recommend insulating oil lines, oil pressure lines, and the oil tank in cold weather operation. This is to prevent oil from congealing and causing damage to the engine and other oil-dependent systems.

Many people seem to fly their aircraft during the summer, store over winter and then consider having the annual and routine maintenance carried out in the spring, so that the aircraft is in perfect order for the new season.

This is fine to a certain extent, but if you do no other maintenance in the autumn, then you should remove the old oil from your engine and refill with the appropriate grade.

The problem of leaving the old oil in the engine is that used oil can be quite acidic which, when combined with water from the atmosphere, causes corrosion. This can lead to pitting of components like cam lobes, bearings etc. if left in the engine over a period of time.

This problem is then compounded when the rust particles that are formed get into the oil and act like a grinding paste when the engine is next started, causing further wear and damage.

This all leads to increased maintenance bills and reduced reliability, all for the cost of an oil change.

Above: Complete Janitrol Aero FAA-PMA approved South Wind replacement heater kit.

Winterization kits

Some aircraft may require baffles, winter fronts, or oil cooler kits during cold weather operation. If baffles are installed, it may be necessary to install a cylinder head temperature gauge to avoid overheating the engine if the owner flies from the cold weather environment to a warmer location.

Engine condition

Since cold weather starting is harder on an engine than starting in warm weather, the engine in general should be in excellent operational shape. In its flyer reprint titled "Cold Weather Operation" Lycoming offers the following advice: "When attempting a start under adverse conditions, it is imperative that the engine be well maintained and in excellent operating condition. Spark plugs and magneto points should be properly gapped and ready to function effectively. In addition to the ignition system, the proper functioning of other systems such as the induction, priming, exhaust, and carburetor heat can have an effect on the starting and operation of the engine."

Another important part of cold weather preparation is to inspect all hose lines, flexible tubing, and seals for deterioration. Replace all suspect components and ensure all clamps and fittings are properly torqued to the manufacturer's specifications for cold weather.

Control cables should also be checked in cold weather operation. Temperature changes can cause expansion and

Above: Dual Advisory Ice Detection System. Severe ice detected on ECAM display.

contraction of metals, and adjustments may have to be made to compensate for these changes.

Preheating

Another important factor to consider in cold weather operation is engine preheating. In addition to difficulty starting the engine, failure to preheat an engine in cold weather can cause damage to the engine. It can lead to minor amounts of abnormal wear to internal engine parts and eventually to reduced engine performance and shortened TBO time. Lycoming recommends engine preheating anytime temperatures are 10F. The exception to this is its 76 Series models that include the O-320-H and O/LO-360-E. It recommends preheating these engines when temperatures are below 20F.

Some carbureted engines, like the O-470 in the Cessna 180 and 182, run markedly better if partial carburetor heat is applied during cruise flight in cold weather. A carburetor temperature gauge is necessary to practice this art, which consists of adding carb heat to maintain a 10C /50F carb throat temperature.

Water contamination

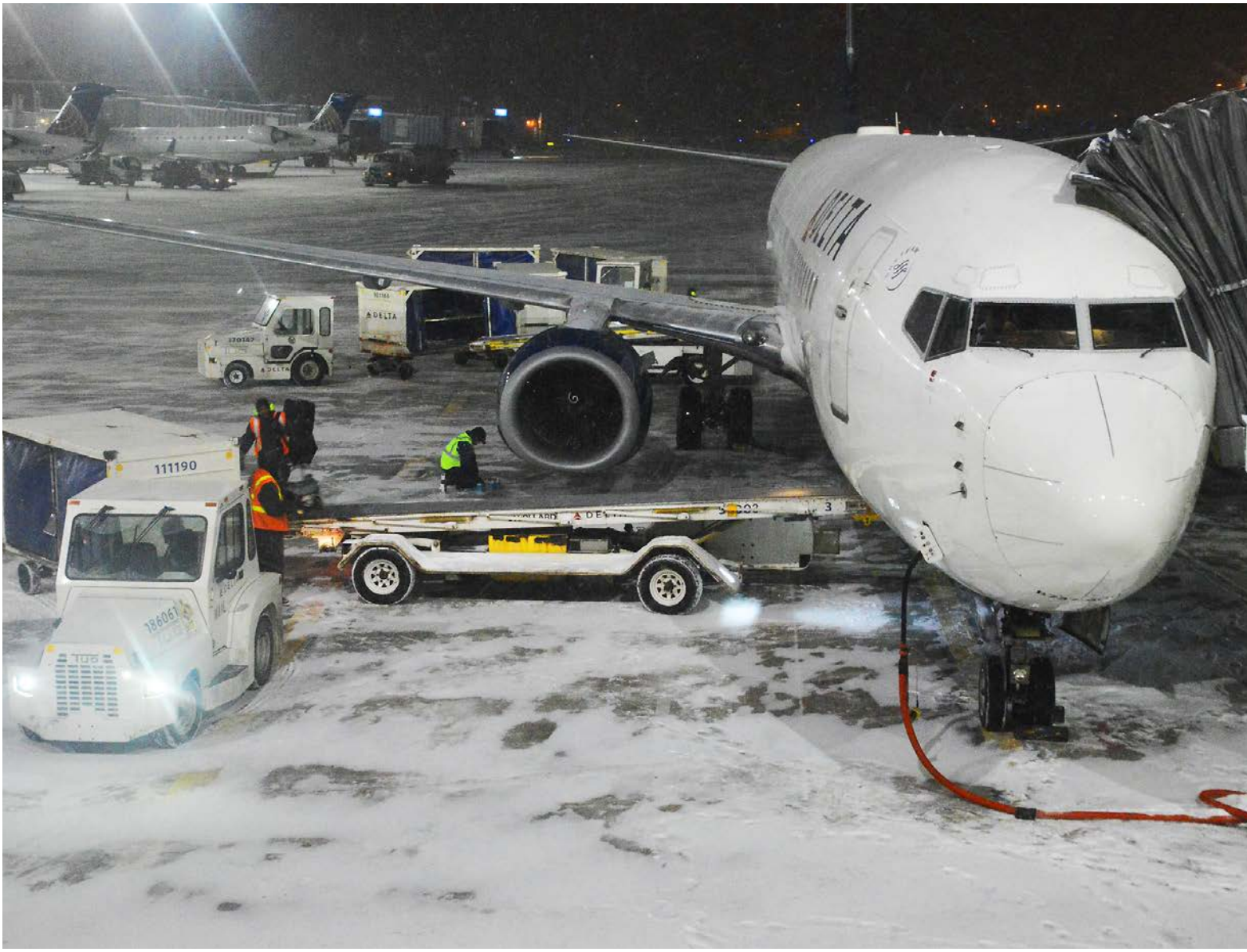
Water contamination in the gas is another important issue to keep in mind. We need to be vigilant in ensuring excessive water is not present in the fuel. Unlike in warm weather where small amounts of water will not have a significant effect on engine operation, flying in freezing conditions makes any moisture in the system potentially dangerous.

There are several things that can be done to prevent water from contaminating the gas. First of all, ensure all tanks are topped off whenever possible. The fuel absorbs the humidity in any air present in tanks that are not topped off. We should also ensure that all fuel caps are properly secured to prevent any rain or snow from contaminating the system. In addition, a vigilant fuel sampling/draining program can help ensure that any moisture present can be detected and removed before it adversely affects the engine. All fuel tanks and sumps should be drained before each flight.

On the subject of fuel, there is one thing you need to be careful of — inadvertent fuel spills caused by temperature differentials. The problem occurs when an aircraft that is topped off and sitting out on a cold ramp (cold soaked) is taken inside a warm hangar for storage or maintenance. As the fuel warms up, it will expand. This can lead to fuel being dumped overboard, causing a fire hazard and a mess to clean up.

Oil breather

The crankcase breather deserves special consideration in cold weather preparation. The FAA reports that a number of



Above: Water contamination in the gas is another important issue to keep in mind when preparing for winter operations.

engine failures have resulted from a frozen crankcase breather line, which caused pressure to build up, sometimes blowing the oil filler cap off or rupturing a case seal, which caused the loss of the oil supply.

The water, which causes the breather line to freeze, is a natural by-product of heating and cooling of engine parts. When the crankcase vapor cools, it condenses in the breather line subsequently freezing it closed. Before flight ensure that the breather system is free of ice.

If a modification of the system is necessary, be certain that it is an approved change so as to eliminate a possible fire hazard.

Batteries

Wet cell batteries require some extra attention during cold weather. They should be kept fully charged or removed from the aircraft when an aircraft is kept parked outside to prevent loss of power caused by cold temperatures and the possibility of freezing. If a battery is discharged because of hard starting conditions, don't allow it to remain in a discharged state. Ensure that it is charged immediately to help avoid any damage to the battery.

Propeller

Do not move the propeller during a period of engine inactivity, as it will wipe the oil coating off the internal components of the engine. Cylinder dehydrating, or "Protek" plugs contain a silica gel that will help protect the cylinders. They start blue and turn pink as they absorb moisture. A bag of silica gel can be placed in the intake and exhaust and taped over as well. Just make sure there is a streamer attached, so they're not missed during de-preservation! ■

Western AME Association

Transport Canada letter to the aviation community

The legalization of recreational cannabis in Canada on October 17, 2018, serves as an important occasion to remind the aviation industry of its obligation to operate aircraft in a manner that is not impaired by either alcohol or drugs. To contribute to a safe and secure transportation system, a number of legislative and regulatory measures exist today that prevent and deter the impaired operation of aircraft.

This letter applies to the Canadian aviation community, including industry, management and labour organizations, operators, pilots, and professional associations. The Government of Canada has passed legislation to legalize, strictly regulate, and restrict access to cannabis. The Cannabis Act creates a strict legal framework for controlling the production, distribution, sale, and possession of cannabis in Canada. The legislation allows adults to legally possess and use cannabis.

Transport Canada is responsible for dealing with fitness for duty considerations such as medical state and impairment as they relate to safety in air, marine, rail and motor vehicle modes of transport by federally-regulated employers. Transport Canada is aware that the Canadian aviation community may be concerned about the upcoming legalization of cannabis and are seeking guidance.

Cannabis use can cause immediate impairment but also causes longer-lasting impairment that may not be obvious to the user or to the people around them. Cannabis, like many other substances such as narcotics, muscle relaxants, anti-depressants, etc., causes impairment that can affect the judgment and actions of members of a flight crew, including pilots. There is scientific consensus regarding the long-lasting effects of cannabis on individuals, even after impairment is no longer felt. However, current tests for the psychoactive chemical in cannabis do not correspond with impairment levels. As a result, in the interest of safety, Transport Canada does not intend to ease restrictions on the use of cannabis or other substances that cause impairment.

Impairment caused by cannabis use is a serious issue for Transport Canada given its potential to threaten aviation safety. Despite the impending legalization of cannabis, Transport Canada has an existing regulatory framework in place concerning impairment. Pursuant to the Aeronautics Act and the Canadian Aviation Regulations (CARs), regulations and medical standards address the consumption of drugs and alcohol by certificate holders, such as pilots. The CARs, under section 602.03, set out the rules governing alcohol and drug use.

Currently, the use of cannabis is a disqualifying factor for obtaining a medical certificate to fly or control aircraft. The CARs currently provide that all members of a flight crew, such as pilots, are prohibited from working while using any drug (legal or illegal) that impairs faculties to the extent that the safety of the aircraft or people on board is endangered in any way. The definition of a drug includes cannabis and, therefore, these regulations will continue to apply once the Cannabis Act comes into force. Transport Canada has a robust medical protocol and testing regime in place in order to address substance abuse disorders. Canadian medical certificate holders with a known diagnosis of substance use may be subject to no-notice drug and alcohol testing to ensure compliance with the abstinence provisions of their certificate.

Taking cannabis, and products containing it, across any international border is illegal and can result in serious criminal penalties in Canada and in other countries, including the United States. The import and export of cannabis will remain illegal after the legalization of cannabis in Canada, and also when travelling to or returning from jurisdictions with legalized or decriminalized cannabis. This includes cannabis for medical purposes.

Each country or territory decides who can enter or exit through its borders. The Government of Canada cannot intervene on your behalf if you do not meet your destination's entry or exit requirements. During state control procedures, pilots or other crew members may be denied entry to a foreign country, including the United States, if they have previously used cannabis products, even if these products were used legally in Canada.

Transport Canada remains committed to ensuring a robust evidence-based regulatory framework when evaluating the various policy options and measures needed to mitigate impairment risks. In collaboration with Justice Canada, Health Canada, and Public Safety Canada, Transport Canada remains vigilant in ensuring that the issue of impairment, which includes impairment from cannabis use, undergoes proper policy rigour and legal analyses to safeguard aviation safety while balancing the legal rights and responsibilities of employees and supervisors.

If you have any further questions concerning the legalization of cannabis use, please do not hesitate to contact me. Thank you for your continued interest in maintaining the high safety standards of Canada's aviation industry.

— *Nicholas Robinson Director General, Transport Canada, Civil Aviation*
— *François Collins Associate Director, General Transport Canada, Civil Aviation*

Symposium and Trade Show

The Western AME Association is pleased to announce we have confirmed the date and time of the next symposium and trade-show. You can find us at the Coast Plaza in Calgary on March 20-22, 2019 with the theme "The AME, Guardian of the Vested Interest."

About Us

The Western AME Association is one of five similar associations across Canada, the others being the Atlantic, Ontario, Central and Pacific associations. These associations represent regional interests as well as concerns of national importance.

The Western AME Association 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.

www.wamea.com

AME Association of Ontario

c/o Skyservice F.B.O. Inc., PO Box 160, Mississauga, Ontario L5P 1B1
tel: 1-905-673-5681 fax: 1-905-673-5681
email: association@ame-ont.com website: www.ame-ont.com

About Our Association

The Aircraft Maintenance Engineers (AME) Association of Ontario is one of five similar associations across Canada, the others being the Atlantic, Central, Western, and Pacific associations. These associations represent regional interests as well as concerns of national importance. The membership is comprised of AMEs, non-licenced personnel working in the industry, students and apprentices, as well as corporate members. The Canadian Federation of Aircraft Maintenance Engineers Associations, (CFAMEA), is a national body which is supported and financed by all the regional associations and which represents the associations at the national level.

The AME Association of Ontario is a non-profit organization, run by a volunteer group of AMEs and non-AMEs. Member AMEs elect directors to the board for a two-year term. The purpose of the association is to maintain and enhance the standards of professionalism of the AME and the aircraft maintenance industry as a whole, and to promote the rights and privileges of the AME.

The association works with and is consulted by Transport Canada in the formulation of new rules and regulations to promote the viewpoint of the AME. We are represented on various committees and working groups involved with aircraft maintenance and licensing. We support the community college aircraft maintenance programs in Ontario through annual monetary awards to their top students.

Two workshops are conducted annually: one in the Toronto area and the other in Thunder Bay. Separate committees under the auspices of the association run these workshops. The workshops (Toronto is a two day event and Thunder Bay is a single day event) feature speakers on a variety of topics.

An industry trade show with over 50 booths from various companies, suppliers, manufacturers, and other organizations is part of the workshop presentation. Attendance at this and our various other workshops and training sessions can be counted towards the recurrent training requirements by Transport Canada. We publish periodic newsletters, which contain items of current interest to our members as well as commentaries and articles on maintenance procedures.

Central AME Association

23rd Annual Manitoba Aviation Symposium

February 27- 28, 2019
Canad Inns Destination Centre Polo Park
1405 St Matthews Ave., Winnipeg, Manitoba

Speakers at this year's symposium:

Transport Canada
Prairie Northern Region Panel on Local Issues – Tom Bennet
Aircraft Flight Authorities, A Primer – Brian Clark
Investigations and Continuing Airworthiness – Jean Grenier

Soft Skills
Crew Resource Management – William Grassick
Component Reliability & Impact on Operations – Maze Hobeyn/Jazz
Avoiding Technician Shortages – Attrition and Basic training options for developing new talent – Niel Lavoie / RRC
Developing a Training Program – Brian Deane
Marijuana in the workplace – Tracy Epp

Technical
Continental Fuel Injection – Wayne Cathers/Aero Recip
Common problems – Wayne Cathers /Aero Recip
Marvel Schebler Aircraft Carburetors & RSA Fuel Injection Systems, maintenance and troubleshooting – Alan Jesmer /Tempest
PT6 Engines – Patrick Guerreiro /Standard Aero
King Air Troubleshooting Tips and Techniques – Robert Horne/ Textron Aviation Inc.
APS Brakes

If you'd like to contribute your professional association's newsletter to AirMaintenance Update, contact our editor, John Campbell via email at: amu.editor@gmail.com

ATLANTIC

Atlantic AME Association

Our Objective

To provide a forum of AMEs elected by AMEs or AMEs voluntarily offering to serve on such a body, to act as a vehicle to represent the views and objectives of the AME Association (Atlantic) Inc. at any level required to preserve or alter as the case may deem necessary, the rights, privileges and legislation of AMEs as a whole.

ARAMC 2019

ARAMC 2019 will be held in Moncton, at the Delta Hotels by Marriott Beausejour, New Brunswick from April 24-26. More information will be added as it becomes available.

www.atlanticame.ca

PACIFIC

Pacific AME Association

www.pamea.ca

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).

Mission Statement

The Pacific AME Association promotes and protects the professionalism of the AME, while developing, maintaining and improving our relations with regulatory bodies affecting our industry. We represent the views and objectives of our members, while promoting proficiency through educational collaboration with other groups on matters of mutual interest.

DALLAS - FT. WORTH

PAMA Dallas – Fort Worth

The DFW PAMA Scholarship Fund provides support for deserving Airframe, Powerplant and Avionics students and seeks to improve the training, education and reputation of individuals who are involved in aerospace maintenance and management.

Eligibility Criteria

- Must be currently enrolled at or entering Tarrant County College with the intent to pursue an Associate of Applied Science Degree in Aviation Maintenance Technology.
- Must enroll as a full-time student, up to a maximum of 17 hours, in the Aviation Maintenance Technology Program, taking a full load per the flow of classes outlined by the Aviation Department.
- Scholarship will fund only AERM classes to include tuition, fees and textbooks plus the Federal Aviation Administration written examinations at the rate assessed for a Tarrant County resident, as calculated on an annual basis.
- Must have a minimum TCC GPA of 2.5 or high school equivalent if a first-time TCC student.
- Must not have been convicted, in the past calendar year, or be convicted while receiving scholarship funds, for a violation of any federal or state statutes pertaining to narcotic drugs, marijuana and depressants or stimulant drugs or substances.
- Is a merit-based scholarship.
- Will continue to receive a scholarship, for up to the duration of the program, if a minimum semester GPA of 2.5 is achieved each semester and all courses are completed.
- Must become a member of the Dallas/Fort Worth Chapter of the Professional Aviation Maintenance Association.
- Must attend a PAMA DFW meeting per semester or write an aviation-related maintenance report, coordinated with the chapter.
- Must complete one testimonial report prior to graduation that can be placed in the local and national newsletters.

Application Process and Scholarship Amount

Complete the TCC Foundation scholarship application.First-time TCC students: an academic transcript, if applicable. Submit to the Foundation office. Tuition, fees and textbooks for AERM classes; up to 17 hours per semester

www.pamadfw.com

PAMA SoCal Chapter

September 2018 Meeting Wrap

The SoCal Chapter thanks Mr. Todd Levine, VP of Extraord-N-Air and Bill Johnston, Aircraft Logbook Industry Advisor of V-Log for their time, generosity and excellent technical presentation on "Aviation Maintenance Professional Knowledge Update: A review of highlights that an Aviation Maintenance professional should be aware of" on September 11, 2018 at the 94th Aero Squadron Restaurant in Van Nuys, California.

2019 Chapter Scholarships
(www.SoCalPAMA.org)

A&P Student Scholarship A&P/IA Continuing Education Scholarship
Deadline: April 1, 2019
Awards Presentation: June 11, 2019
Open to all Southern California residents currently enrolled in good standing in an accredited A&P or IA Training School/Program.

www.socalpama.org

Central Ohio PAMA

The Danger of Working with Cordless Tools

This situation happened recently to someone I know. After hearing about it, I had to ask why or how this same thing never happened to me. I'm sure in the same circumstance most of us would have done the exact same thing. I believe it would be almost impossible to find a hangar not using cordless electric drill/drivers today. My friend's body was found in the corner of the hangar behind a Cessna amphibian 206.

That's where he collapsed, and also where a fellow employee extinguished the fire on him. He was assisting with the annual on a Cessna 414 that had not been defueled, and the employees believed there were 100 gallons in that wing. He was supposed to be removing a panel by the left main landing gear for inspection of that area. We can only speculate that maybe he was distracted and attempted to remove the fuel panel by mistake.

As he started removing the panel, fuel started leaking and running down his drill and onto his arm and onto his chest and face, he did what all of us would do ...stop the leak by reinstalling the screws using the drill that is already in his hand. That is when the explosion happened.

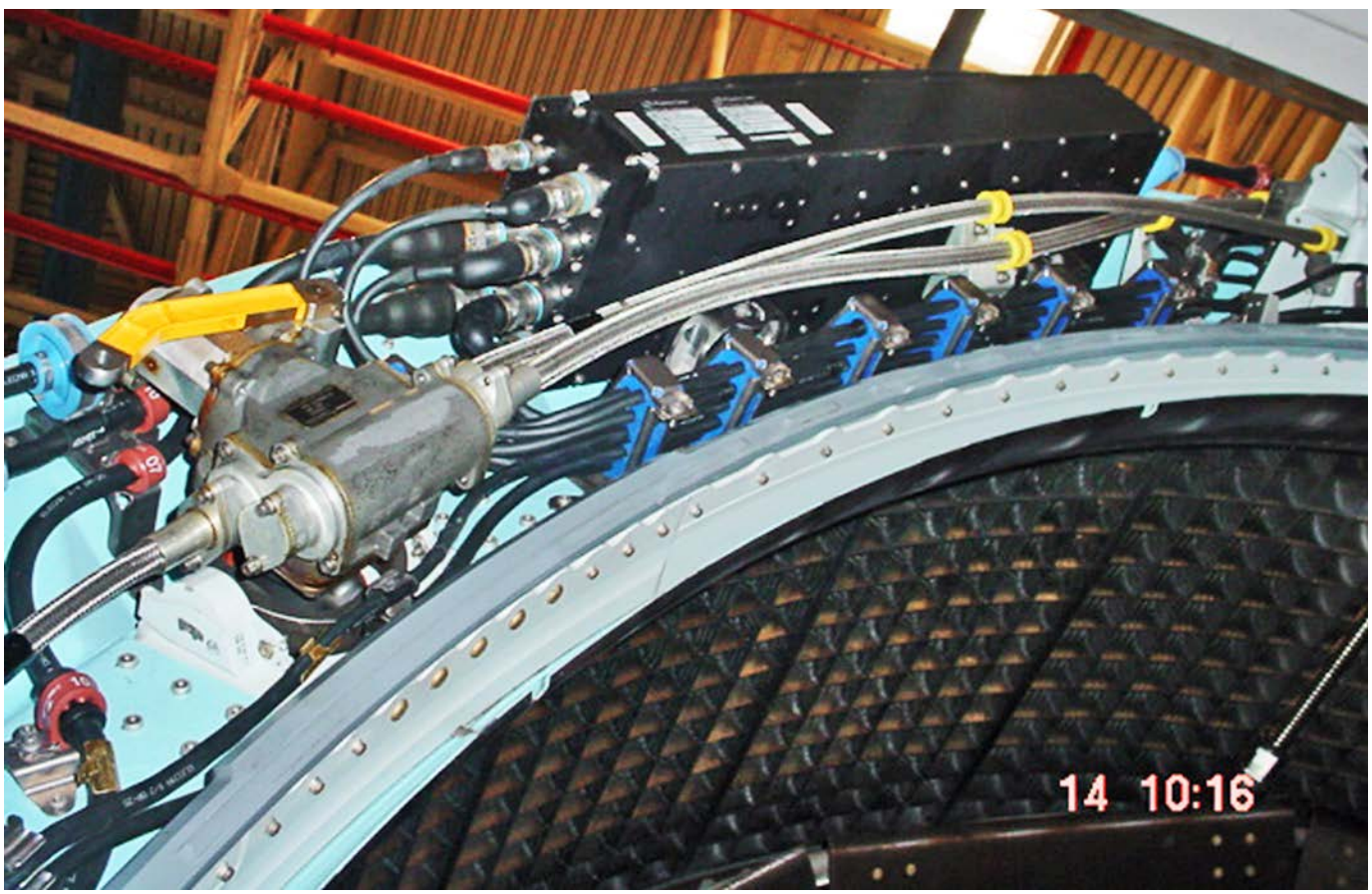
The drill driver was on the floor exactly where he dropped it under the wing. The cause of the fire was the NON-brushless drill motor. This did not have to happen.

— *Chuck Jones, FPM, Sacramento FSDO*

www.copama.org

Versatile Nature

Flexible shafts have been around since the 1870s, and are still working quietly behind the scenes, delivering rotary motion and flexibility to applications in the aerospace industry.



Above: Another look at how TRAS on commercial aircraft employ flexible shafts.

BY STEVE GRIMES

In the aerospace industry, the importance of creating problem-solving technologies to meet the challenges of manufacturing highly complex, critically reliable machines cannot be overstated. In the history of aerospace manufacturing, there have been several innovative technologies that have changed the shape of flight. Some of these technologies aren't well known or hugely influential on their own, like the propeller or jet engine, but are instead innovations that occurred behind the scenes, quietly enabling steady, vital improvements to aerospace technologies in various ways.

One case in point is the flexible shaft. Put simply, a flexible shaft is a precisely defined and configured nested group of springs, tightly wound so that it has torsional or rotational strength, as opposed to the tensile strength found in standard wire rope or cable, to which flexible shafts bear a resemblance. What makes flexible shafts specifically useful is that flexible shafts can bend, but also still rotate. In other words, a flexible shaft transmits rotary motion much like a solid shaft, but it can be routed over, under, and around obstacles that would make using a solid shaft impractical.

Above: A jet afterburner up close. Flex shafts drive the actuators that open and close it.

A flexible shaft assembly consists of a rotating shaft (sometimes called a core) with metal end fittings for attachment to mating parts. A protective outer casing is used when necessary. This casing has its own fittings (ferrules) that keep it stationary during use and can serve as an environmental protection.

A flexible shaft is an effective means of transmitting rotary motion and is more efficient than universal joints, gears, sprockets and chains, and belts and pulleys. It is typically lower in cost than these other devices and offers the added benefit of compensating for misalignments.

Flexible shaft assemblies are used in everything from the Boeing 787 Dreamliner to children's toys. Their exceptionally long lives are not affected by continuous operation at speeds up to 50,000 rpm, and they can withstand temperatures ranging from -300 degrees to 1,000 degrees Fahrenheit.

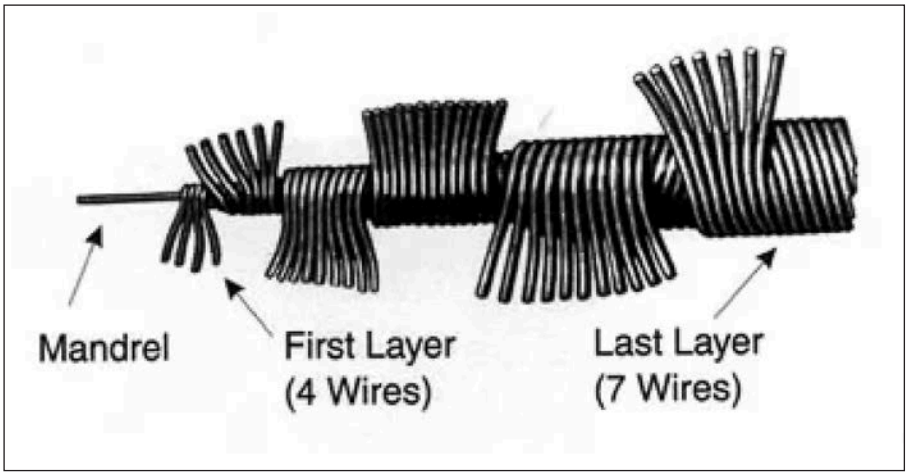
Aerospace Applications

Flexible shafts are used in a great variety of aerospace applications, as their characteristics perfectly meet the challenges of aerospace manufacturing. Some common or especially vital applications include thrust reverser actuation systems (TRAS), flap actuation, valve override systems, pedal adjustment systems, rescue hoists, afterburner nozzle actuation, canopy actuation, refueling tubes, and more.

Flexible shafts are a key part of TRAS systems on many large commercial aircraft. TRAS systems are essentially an engine break for these aircraft. Located at the back of the engine, the thrust reverser of a turbo fan jet engine essentially closes the by-pass and diverts the thrust forward to slow the plane.

In forward motion, the thrust comes in the intake and out the exhaust and by-pass. In the stop motion, the thrust comes in the intake and since the by-pass is closed, the thrust reversers divert the by-pass flow through forward facing matrices, causing the plane to stop. There are four flexible shafts used in this system, which synchronize and connect the actuators that open both halves of the thrust reverser. There are two other flexible shafts used in the trans cowl lock, which keep the TRAS from deploying while in flight.

Another notable application in which flexible shafts are deployed is in the flap and slat systems, especially on slightly smaller aircraft, such as business jets. Flaps and slats are moveable wing surfaces that extend during takeoff and



Above: A look at the inner construction of a flexible shaft.

landing to change the wings' profile to produce "high lift" at lower airspeeds. During flight, flaps and slats retract to reduce wing area and drag at higher speeds, increasing efficiency. The configuration of a flap and slat control system is very similar in most aircraft. Each surface is driven by linear actuators, which are connected to a transmission system centrally controlled from a power drive unit. Flexible shafts transmit the rotary motion from the motor out along the wing to drive the actuators that enable the flap and slats to extend and retract.

An especially demanding application in which flexible shafts are used is that of fighter jet afterburner nozzle control systems. A fighter jet afterburner is comprised of a set of fuel injectors, a tube, a flame holder that the fuel burns in, and an adjustable exhaust nozzle.

The actuators controlling the nozzles opening and closing are driven and synchronized by a series of flexible shafts that ring the engine. These flexible shafts are engineered to withstand the extreme temperatures and torque loads presented by this demanding application.

Why Flexible Shafts?

While some applications in which flexible shafts are deployed appear extremely complex or demanding, other applications seem straightforward. However, flexible shafts are a constant in all these applications. In fact, flexible shafts are often the preferred choice in aerospace applications for rotary motion transmission over gearboxes, universal joints, and belts-and-pulleys.

Why is it that flexible shafts are the best technology to use in so many aerospace applications? There are a number of reasons, and while many of these reasons depend upon the specific application at hand, there are other, more general reasons for the flexible shafts' superiority that hold true across almost all applications.

In general, flexible shafts are the preferred rotary motion transmission device because they:

Above: Flexible Shafts transfer torque where a direct connection is not possible.

• Eliminate alignment problems: Flexible shafts have no need for the tight tolerance that solid shafts require.

• Are more efficient: Flexible shafts are typically 90 to 95 percent efficient. Gears, U-joints, belts and pulleys have much lower efficiencies due to greater frictional losses.

• Are both lightweight and powerful: Flexible Shafts have a 3:1 weight advantage over other design solutions while transmitting greater power loads.

• Are less susceptible to vibration: Vibrations, a constant occurrence on aircraft, do not affect flexible shafts performance.

• Reduce parts cost: Bearings and housings for solid shafts and gears require precise machining operations. Flexible shafts eliminate the need for such demanding tolerance and their excessive costs.

• Are easy to install: Flexible shafts can be installed without the need for precise alignment or special installation tools.

• Have a lower installation cost: Flexible shafts install in minutes without special tools or skills. Solid shafts, gears, pulleys, and universal joints require precise alignment and skilled mechanics for their installations.

• Allow large offsets: Flexible couplings allow only five degrees of offset and U-joints 30 degrees, but with a 40 to 50 percent decline in efficiency. Flexible shafts permit a full 180-degree offset while maintaining their high efficiency.

• Can be designed in the latter stages of a project: Unlike other rotary motion devices that need to be designed around because of their rigidness, defined configurations, and large mass, flexible shafts allow greater design freedom because engineers have only one piece to work on, eliminating complex coordination of multiple pieces.

• Provide greater design freedom: Flexible shaft technology offer limitless possibilities in position motor and driven components.

The last point is especially important. One company, S.S. White Technologies, has been designing flexible shafts since 1874 (interestingly, the first one was used in dental equipment) and is now a leading manufacturer of them for aerospace applications. Many of S.S. White's flexible shafts are custom-designed for each application to maximize their efficiency and effectiveness.

This is part of the beauty of the flexible shaft. Each individual flexible shaft assembly can be carefully designed and created to meet the needs of a specific application. If one application needs exactly this much torsional strength or power, the flexible shaft can be made to match that exactly. This is not easy to do.

Flexible Shafts are a surprisingly complex product and not easily modeled by simple calculations. For example, one of the most challenging aspects of designing a flexible shaft is balancing the opposing properties of bending flexibility and torsional deflection. This problem is solved with a program called Perflexion, a proprietary computer modeling software based on the pioneering work of Dr. Adam Black.

This is part of the beauty of the flexible shaft. Each individual flexible shaft assembly can be carefully designed and created to meet the needs of a specific application. There are limitless possibilities held by flexible shafts in aerospace applications . . .

It is a powerful tool that allows design engineers to optimize the performance characteristics of a Flexible Shaft. Prior to the use of Perflexion it was nearly impossible to optimize one of a flexible shaft's characteristics. With Perflexion, S.S. White can now fully model the behaviour of all the wires within a flexible shaft and arrive at a design that provides maximum bending flexibility while allowing minimal torsional deflection with 20 to 30 percent improvement above accepted industry standards.

There are limitless possibilities held by flexible shafts in aerospace applications. When transmitting rotary motion, especially in a tight space, the flexible shaft cannot be beat in its efficiency, effectiveness, cost, versatility, and durability. An argument can be made for the flexible shaft being one of the backbones of the aerospace industry, and it isn't difficult to see why. From windshield wipers to TRAS systems to jet afterburners, flexible shafts are there, doing their job quietly and efficiently, unbeknownst to many, but indispensable to all.

(Steve Grimes is Director, Sales & Marketing, S.S. White Technologies, Inc.) ■

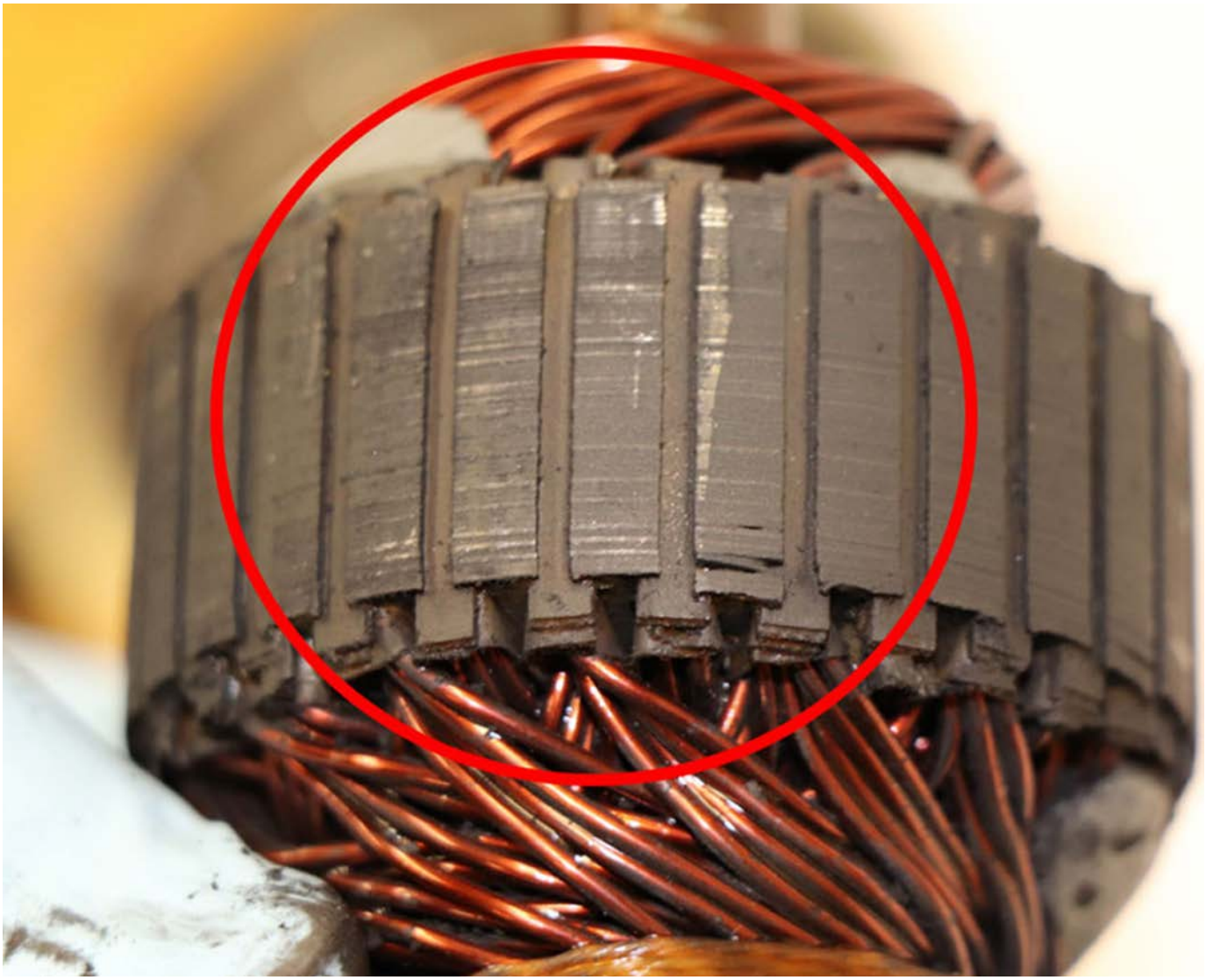
Two to Tango

Questions arise in Winnipeg when an aircraft fails to respond to brake pedal inputs.

On April 15, 2018, the privately registered Cessna Citation Bravo 550 (Cessna) aircraft (U.S. registration N4AT, serial number 550-0805) was conducting a flight from Calgary International Airport (CYYC), Alberta, to Bedford/Laurence G. Hanscom Field Airport (KBED), Massachusetts, United States, with a fuel stop at Winnipeg/James Armstrong Richardson International Airport (CYWG), Manitoba.

The Cessna landed on Runway 36 at CYWG at 1435 and taxied to Apron II with the pilot and 1 passenger on board. A ground marshaller guided the aircraft to park at the Fast Air Jet Centre's ramp. Once the aircraft was shut down at the assigned parking spot, the pilot and passenger waited in the passenger lounge while the aircraft was fuelled.

Approximately 20 minutes later, once fuelling was complete, the pilot and passenger returned to the aircraft and prepared for departure to KBED. The engines were started under the guidance of a ground marshaller. As the aircraft engine power was applied to begin the taxi, the pilot attempted to turn left to taxi toward Taxiway C, and away from other aircraft on the apron, by applying left rudder pedal input and left brake. The aircraft did not respond to the brake input and did not turn as expected.



Above: Scarring marks on armature.

Because the aircraft was not turning, but was accelerating, the pilot attempted to stop it by applying pressure to both brake pedals. However, the aircraft brakes did not respond and the aircraft continued to accelerate. The pilot did not attempt to apply the emergency brake.

The Cessna's right wing subsequently collided with the nose gear of a Morningstar Partners Ltd. Bombardier CL-600-2B16 (Challenger 605) aircraft (registration C-FXWT, serial number 5824), which was parked facing the Cessna. As the Cessna's right wing contacted the Challenger 605's nose gear, the Cessna pivoted right and its nose contacted the Challenger 605's right wing.

The pilot of the Cessna subsequently shut down the aircraft's engines, and he and the passenger exited the aircraft through the cabin door. Neither was injured.

Fuel was observed leaking from the Cessna's right wing, and ground crew used a spill response kit to ensure the leak was contained. The ground crew also reported the collision by phoning the airport fire hall directly. There was no fire, and the emergency locator transmitter did not activate.

As a result of the collision, both aircraft sustained substantial damage.

Aircraft information

The Cessna Citation Bravo 550 is a pressurized, turbo-fan–powered corporate aircraft. The occurrence aircraft was manufactured in 1997 by the Cessna Aircraft Company/Textron Aviation. It has a maximum operating altitude of 43 000 feet above sea level and is equipped with retractable landing gear. The aircraft has a total seating capacity of 10, including the pilot and co-pilot seats. The aircraft is approved for day and night visual flight rules and instrument flight rules operations. The occurrence aircraft is registered in the U.S. and is maintained in accordance with FAA regulations.

Weight and balance

The occurrence aircraft has an empty weight of 9173 pounds and a maximum take-off weight of 14 800 pounds. At the time

of the occurrence, it had 4860 pounds of fuel on board and a total gross weight of 14 758 pounds. The aircraft was within the allowable weight and centre of gravity limitations for the intended flight.

Hydraulic brake system

The occurrence aircraft is equipped with a hydraulic, multi-disc, anti-skid/power brake system. The anti-skid provides maximum braking efficiency by preventing the wheels from locking up, while the power brake allows for smooth, power-assisted braking action. When the aircraft is ground manoeuvring at speeds of less than 12 knots, the anti-skid function is disabled.

Hydraulic pressure for the anti-skid/power brake system is provided by a hydraulic pump driven by an electric motor that is controlled by a pressure switch, which opens when the system pressure reaches 1300 psi and closes at 900 psi.

An accumulator is incorporated to maintain system pressure when the pump is not running. If the system pressure drops below 750 psi, a low-pressure switch closes and illuminates the amber LO BRK PRESS (low brake pressure) light on the annunciator panel.

Power braking action is actuated by the master cylinders that are connected to the top of each rudder pedal and that are commonly referred to as toe brakes. When the pilot applies the toe brakes, hydraulic pressure produced by the master cylinders actuates the power brake and anti-skid valve that applies power-assisted braking action to the wheels.

Emergency brake

In the event of a hydraulic brake system failure, including a brake pump failure, braking action is only available through the emergency/pneumatic brake system.The aircraft is equipped with an emergency air bottle, which supplies high-pressure air for emergency braking action and emergency landing gear extension. The emergency brake is controlled by a hand-operated valve located under the instrument panel that directs high-pressure air to each brake.

Inspection of brake components

The hydraulic motor and pump assembly (part number MP50B-1) and power brake low-pressure switch (part number 9912163-1) were shipped to the TSB Engineering Laboratory in Ottawa, Ontario, for further inspection.

Hydraulic motor and pump assembly

The TSB's on-site examination of the aircraft and subsequent laboratory testing of the hydraulic motor and pump assembly revealed that it would not operate. Disassembly of the motor revealed excessive wear of the armature bearings and scarring on both the armature and the stator. The scarring is indicative of the armature making contact with and binding against the stator.

The hydraulic motor and pump assembly is maintained according to an on-condition maintenance requirement, which consists of a scheduled visual inspection and a system operational check, as specified by the aircraft manufacturer. The last scheduled visual inspection was completed on 01 May 2017, approximately 82 flight hours prior to the occurrence. No abnormalities were noted or recorded.

Power brake low-pressure switch

On-site examination revealed that the LO BRK PRESS annunciator light would not illuminate when the brake pressure was below 750 psi. Laboratory testing of

Above: Collision site, showing N4AT (left) and C-FXWT (right).

the power brake low-pressure switch revealed that the switch was in a constant open state. Further analysis revealed internal contamination with hydraulic fluid and damage to the secondary seal.

The pressure plate was found jammed in the open position, likely the result of corrosion caused by hydraulic fluid. The open state of the switch prevented the power brake low-pressure light on the annunciator panel from illuminating in a low-brake-pressure situation. Maintenance of the power brake low-pressure switch consists of a scheduled visual inspection and a system operational check and is maintained according to an on-condition maintenance requirement. The last scheduled visual inspection was completed on 01 May 2017, approximately 82 flight hours prior to the occurrence. No abnormalities were noted or recorded.

Emergency response

After the collision, Fast Air Jet Centre staff initiated fuel containment procedures, including covering a drain with a

Above: N4AT.

> . . . the emergency brake system was not activated when the aircraft did not respond to the brake pedal inputs . . . Pilots should be cognizant that malfunctions may occur . . .

rubber pad and creating a barrier to prevent fuel from entering the drain. A plastic barrel was also placed under the Cessna's wing to capture the leaking fuel. The phone call from Fast Air Jet Centre staff was made directly to the airport fire hall rather than to the airport's emergency phone number, and the caller did not specify that two aircraft had collided and a significant fuel spill was occurring. When the airport's fire department arrived at Apron II and the scale of the incident was observed, the airport's emergency response was activated by emergency response staff. During the post-incident clean up, it was estimated that 55 litres of fuel was recovered from the ground and 30 litres were captured in the barrel.

Safety messages

In this occurrence, the emergency brake system was not activated when the aircraft did not respond to the brake pedal inputs prior to the collision. Pilots should be cognizant that malfunctions may occur at any time, and they should be prepared to initiate emergency procedures. Conducting a brake check to verify proper brake operation on initial movement of the aircraft may alert pilots to issues with the brake system.

This occurrence also highlights the importance of notifying the appropriate agency when a significant incident occurs to ensure that hazards are properly contained. Because the fire hall was called directly, the scale of this incident was not captured in a timely manner. The operator of the airport's emergency phone line is trained to ask specific questions to ensure that the scale of the incident is captured and that a proper emergency response is initiated.

Safety action taken

The Winnipeg Airports Authority has reminded all of its tenants of the importance of calling the appropriate airport emergency phone number for all airport-related emergencies. It has also created posters that can be placed around the airport facilities to remind staff of the phone numbers to call in the event of an airport-related emergency.

(This concludes the TSB's limited-scope investigation into this occurrence. The Board authorized the release of this investigation report on October 17, 2018. It was officially released on October 30, 2018.) ■

Aviation Services

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Transformation In 3D

How a walnut-sized part changed the way GE Aviation builds jet engines

BY AMY KOVER

A jet engine fuel nozzle doesn't look like much. Shaped like a water faucet perched atop two stubby legs, it resembles a forgotten piece of plumbing equipment small enough to hold in the palm of a hand. Few would ever guess that this unimposing object is among the most disruptive pieces of technology in GE history — one that gave rise to the world's best-selling commercial jet engines, ignited a new GE business unit and showed the world just what 3D printing can do.

It all started a decade ago, when CFM International, a 50-50 joint venture between GE Aviation and France's Safran Aircraft Engines, was developing the LEAP engine, a new commercial jet engine that promised to burn less fuel than existing engines and release fewer emissions. As ambitious plans for the engine unfolded, Mohammad Ehteshami, the head of engineering at GE Aviation at the time, quickly recognized its success rested in many respects on the labyrinthine passages inside the tip of the fuel nozzle, which is designed to mix jet fuel with air in the most efficient manner.

To get the job done right, Ehteshami assembled a top-notch team of engineers, including an amateur pilot named Josh Mook, then just 28 years old, whose work with turbine blades had caught Ehteshami's attention. Before long, Mook and his colleagues came up with their dream variant, a walnut-sized object that housed 14 elaborate fluid passages.

But as elegant as it was, the part arrived with a flaw: The tip's interior geometry was too intricate. It was almost impossible to make. "We tried to cast it eight times, and we failed every time," Ehteshami recalls.

Traditional methods wouldn't cut it, but 3D printing just might. The catch: At the time, GE Aviation used additive manufacturing only for prototypes. It had never printed anything for commercial use, much less for an entire fleet of passenger airplanes.

For Mook, who obsessively tinkered with machines as a boy, this was the dream job. Working closely with 3D-printing pioneer Greg Morris — whose company GE eventually acquired — Mook helped re-engineer off-the-shelf 3D printers to meet the fuel nozzle's specifications. Rather than 20 pieces welded together, the new tip was a single elegant piece that weighed 25 percent less than its predecessor, and was five times more durable and 30 percent more cost-efficient.

But the team was far from finished, and GE Aviation needed to figure out how to get its 3D-printing operations ready for mass production. "People think 3D printing is as simple as operating an ink printer, but it's not," says Chris Schuppe, who runs GE Additive's AddWorks team, a group of almost 200 engineering consultants dedicated to accelerating additive adoption for GE's customers. "The fuel nozzle requires orchestrating over 3,000 layers of powdered metal that are about the thickness of a human hair." ■

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