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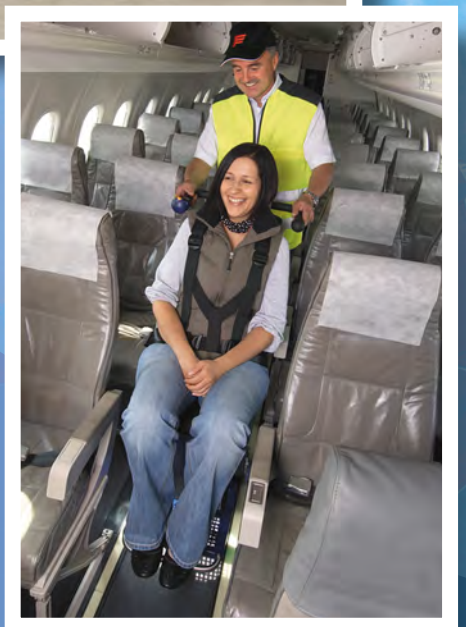

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The Summer of De Havilland?

CALL THIS the Summer of De Havilland Canada. Following closely on the heels of the Paris Air Show in late June when the new Twin Otter Classic 300-G was unveiled (see, AMU Chronicles this issue), DHC announced that its plans to construct De Havilland Field—a new aircraft manufacturing facility in southern Alberta's Wheatland County—have now passed second and third readings by the municipal council and that textual amendments to local land use bylaws will allow DeHavilland to construct its proposed facility within the county, and place shipping containers for the temporary storage of parts and equipment.

Despite some opposition to the project—critics cite the loss of agricultural land space and possible noise pollution—the bylaw amendment is a significant step forward in the development of DHC's 1,500-acre facility that will be located approximately 30 minutes east of Calgary.

The company anticipates the full build will take somewhere between 10-15 years with construction expected to begin in 2024, and the first building completed in 2025. The project will consist of an aircraft assembly facility, runway, parts manufacturing and distribution centres and maintenance repair and overhaul centre. Educational space for training the workforce of the future is planned as well as general office buildings and a De Havilland Canada aircraft museum.

De Havilland Field will be the site of final assembly for the DHC-515 FIREFIGHTER aircraft, which was launched in 2022, as well as the DHC-6 Twin Otter and Dash 8-400 aircraft. The company expects that once in full operation, there will be up to 1,500 jobs located at De Havilland Field. ■

— John Campbell, Editor

Departments

Features

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AirMaintenance Update
Unit 100 - 6660 Graybar Road
Richmond BC V6W 1H9 Canada
phone: (604) 214-9824
fax: (604) 214-9825
email: chrissie@amumagazine.com
website: www.amumagazine.com

editor: John Campbell
art director: Cliff Vickstrom
publisher: Bill Carter
sales manager: Bill Carter
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Upcoming Events

CAREERS IN AVIATION EXPO 2023

THE MONTH OF OCTOBER will see the annual Careers in Aviation Expo program land in Calgary, Alberta as a one-day event that includes aviation exhibitors on hand to communicate with those who aspire to a career in the industry's various segments. Would-be Aircraft Maintenance Engineers, pilots and all levels of flight-ops professionals are invited to attend the Expo where they will gain insight to the many respective career opportunities.

What are the Career Expos?

The Careers in Aviation Expo annual program features two events held in different regions of Canada with the goal of connecting aspiring aviators, graduating students and young professionals with leading companies, organizations and schools. The Careers in Aviation Expo program provides attendees with access to dozens of exhibiting companies and organizations focused on hiring and inspiring a new generation of aviation professionals. The one-day event includes four Main Stage Presentations by industry leaders discussing the challenges and opportunities within a wide range of aviation careers.

What are Expo Breakout Sessions?

In addition to Main Stage Presentations, attendees can sign up for individual Breakout Sessions of approximately 20 to 25 minutes to explore specific career options within a small group led by a mentor. Through an online registration page, attendees can sign up for two Breakout Sessions each with Pilots, AMEs (M1, M2, E, S), Aerospace Engineers, Military Personnel, Airline Operations or Airport Operations, among others.

Who should attend the Expos?

The Careers in Aviation Expo program is designed to provide insight into a range of fixed-wing and rotary-wing aviation careers, including, but not limited to: Pilots, AMEs, Air Traffic Controllers, airport and airline operations, aerospace engineering and design, and flight services.

What sectors are represented at the Expos?

The Careers in Aviation Expo program, through both its educational content and exhibitor program, provides attendees with access to a range of sectors, including, but not limited to: Commercial airlines, business aviation, helicopter operations, training, government and military, engine and airplane manufacturers, supply logistics, and airports, among others. ✪

COMING EVENTS

Las Cruces Air & Space Expo
October 21, 2023
Las Cruces, New Mexico
www.lascrucesairandspaceexpo.com

Careers in Aviation Expo
October 24, 2023
Calgary, Alberta
www.careersinaviation.ca

HAC Conference & Trade Show
November 6-10, 2023
Vancouver, BC
www.h-a-c.ca

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The Magazine for Aircraft Maintenance Professionals

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STCs & new products

L-Type magnets reduce current loss

Arnold Magnetic Technologies now offers L-Type Laminated magnets for high efficiency aerospace applications such as electric propeller propulsion, high speed turbo generators for larger APUs, electric taxi motors, electric flap actuators and more. In utilizing L-Type magnets for motors, having more power doesn't need to mean more heat production. Arnold reduces eddy current losses to ensure efficiency. These magnets have guaranteed performance quality at temperatures of 200C and are available in either Samarium cobalt or neodymium iron boron.

All Arnold permanent magnets are custom made to clients' specifications and project needs. **www.arnoldmagnetics.com**

Carbon fibre replaces wood prop

Working closely with Diamond Aircraft, **Hartzell Propeller** has received a Supplemental Type Certificate from the FAA to replace **Diamond DA40 NG MT wood/ composite propellers** with new and higher performance three-bladed lightweight **Polaris** composite props. The 74-inch diameter three-blade ASCII carbon fibre prop for the Austro Engine E4-A features a lightweight Bantam aluminum hub and 2,400-hour/six-year TBO, with Hartzell's warranty through first overhaul. The propeller for the Diamond delivers low weight, low inertia, and low life cycle costs. Additionally, it provides all-weather durability and the reliability of a carbon-fibre composite propeller. **www.hartzellprop.com**

New batteries require no modification

Gulfstream GV and GV-SP operators now have an option to install sealed lead acid **Concorde batteries** using FAA approved STC ST01097DE. The STC provides for installation of RG-380E/53L, 53 ampere-hour batteries using kit 5-0730. The kit includes battery trays and hold down bars that work in conjunction with the existing mount to accommodate the footprint of the RG-380E/53L battery without modification to the aircraft. Kit 5-0730 also includes Gulfstream charge adaptors which connect to the aircraft side battery charger temperature sensing plugs. **www.concordebattery.com**

MGTOW upgrade is internal increase

MD Helicopters is now offering its MD 530F Maximum Gross Take Off Weight upgrade to operators of all MD 530F model helicopters. The upgrade increases MGTOW from 3,100 to 3,350 pounds. The MGTOW upgrade is an internal weight increase. VNE with the new MGTOW is 150 knots. Maximum external load gross weight, minimum flying weight, and the centre of gravity remain unchanged. The upgrade consists of a new rotorcraft flight manual supplement assigned to the aircraft serial number and a VNE IAS (knots) placard reflecting the increased MGTOW for display in the aircraft. **www.mdhelicopters.com**

Spotlight burns ultra-bright

Streamlight's Waypoint 400, is a rechargeable pistol-grip spotlight offering up to 1,400 lumens of ultra-bright white light with 400,000 candela and a beam distance of 1,265 metres for enhanced down-range lighting capability. The portable light can be used as either a handheld spotlight to aim on a long-range target, or as a hands-free scene light to illuminate an entire work area with its integrated stand. It uses a rechargeable lithium-ion battery that fully charges in four hours. The light is waterproof to two metres and is one-metre impact resistant. **www.streamlight.com**

Mobile kits are in two versions

The new Aviation mobile maintenance kits from **Snap-on Industrial** are on-the-go tool kits built for tool control, organization and visibility, which makes for effective auditing for IS-BAO, SMS and flight safety. They come with sliding drawers or pallets that can accommodate tool control foam cutouts that allow users to quickly identify any missing tools; pallet cutouts also minimize foreign object damage concerns.These kits are available in two versions: an all-weather hard case for protection against the elements or a soft-sided bag to prevent damage to aircraft interior. **www.snapon.com**

To announce your STC or new product, email a JPG photo and a product description to John at: amu.editor@gmail.com

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CITATION MODS COMPLETED BY MID-CANADA

Calgary-based Mid-Canada Mod Center says it recently completed a substantial flight deck upgrade on a Cessna Citation 560XL aircraft, installing a Garmin 5000 Integrated Avionics System. The modifications, completed for a Canadian operator, include three high-resolution flight displays with two intuitive touchscreen controls that require fewer hand-eye movements. The new flight deck is intended to reduce clutter and unnecessary activity while allowing the pilot to control all aspects of the flight—navigation, communication, traffic surveillance, FMS, checklists and intercom and audio systems. Additionally, all engine indications and crew alerting messages are integrated into the flight deck, facilitating enhanced awareness.

AIR AMBULANCE DEPARTURES ON THE RISE

According to data supplied by Toronto-based Horizon Aircraft, the number of air ambulance departures globally is 26 percent higher for the period between January 1, 2023 and July 20, 2023, than for the same period in 2019, before the onset of the Covid-19 pandemic. The corresponding increase in the number of Canadian air ambulance departures between these two periods is 97 percent. The global air ambulance services market was worth around $5.84 billion in 2022 but it is expected to nearly double in size to reach $9.83 billion in 2030. Air ambulances are equipped with amenities designed to provide aid in remote areas.

COMMERCIAL REVENUES EXPECTED TO BOOM

In line with the positive outlook for the aerospace industry, which is expecting commercial revenues to grow 14 percent year-on-year, organizers of the 2024 Farnborough International Airshow reported record-breaking demand for exhibition space, sponsorship packages and marketing activations. The show is set to reach new heights as the preeminent marketplace for an industry on an upward trajectory. Despite the ongoing supply chain challenges, it is estimated that the global airline industry will return to profitability in 2023, reaching $5 billion in profit and $1 trillion by 2030, according to a report by McKinsey and World Economic Forum.

BOEING SAYS HELP WANTED

With the global commercial airplane fleet expected to double by 2042, Boeing forecasts industry-wide demand for 2.3 million new aviation personnel over the next 20 years to support the commercial fleet and meet long-term growth in air travel. The company's 2023 Pilot and Technician Outlook projects that commercial carriers will need significant personnel through 2042 to support the global commercial fleet including 690,000 maintenance technicians, 649,000 pilots and 938,000 cabin crew members. "With domestic air travel fully recovered and international traffic near pre-pandemic levels, demand for aviation personnel continues to increase," said Chris Broom of Boeing Global Services.

HISTORIC FLIGHT CELEBRATES 40TH YEAR

Forty years recently passed since Richard "Dick" Harold Smith touched down in a Bell 206 Jet Ranger III at the Bell Helicopter Hurst Heliport, now known as the Floyd Carlson Airfield. This historic flight marked the completion of the very first solo around-the-world flight by helicopter. In total, Smith covered 32,258 miles (51,914 kilometres) during his journey, logging over 260 hours of flight time. In addition to setting the Guinness World Record for the first solo global circumnavigation, Smith also attained the unprecedented milestone of conducting the first solo helicopter flight across the Atlantic Ocean.

THUMBS-UP FOR P&W F135 UPGRADES

Pratt & Whitney continues to receive positive support for various F135-related program items on the path toward finalizing the 2024 appropriations bill. On July 27, the Senate Appropriations Committee passed a bipartisan bill that included $497 million for the development of the F135 engine core upgrade and a prohibition against integrating any alternate engine on any F-35 variant. The F135 supports nearly 55,000 jobs across 41 states and more than 260 domestic suppliers. In March 2023, the U.S. Air Force, U.S. Marine Corps, and U.S. Navy chose to upgrade the F135 versus replace it with an entirely new engine.

AVIONICS UPGRADES FOR GLOBAL JETS

Bombardier has introduced its new Advanced Avionics Upgrade for the Bombardier Vision flight deck, a new avionics software and hardware package designed to enhance situational awareness. Available for in-service Global 5000-and 6000-series aircraft, the new AAU software allows for the installation of Bombardier's Combined Vision System, which is intended to reduce crew workload and offer the clearest view through tough weather conditions. A Global 6000 business jet is the first aircraft to receive the upgrade, which is currently being installed at the Wichita Service Centre. Operators can also add enhancements such as Airport Moving map/SVS Taxi mode.

DART HELIPORTER DESTINED FOR US NAVY

The Canadian Commercial Corporation has been awarded an indefinite delivery, indefinite quantity contract by the U.S. Department of Defense to provide a high lift heliporter designed and manufactured by Montreal-based MRO DART Aerospace Company to the U.S. Navy. The first heliporter will be delivered by DART to the Naval Air Warfare Center Aircraft Division in Lakehurst, New Jersey and additional units may be purchased over a three-year period. DART has facilities around the world and offers a portfolio of aerospace equipment, services, replacement parts, tooling and completion centres, The Canadian Commercial Corporation is Canada's government-to-government contracting agency.

Fuel Futures

How all sustainable aviation fuel feedstocks and production technologies can play a role in decarbonizing aviation.

SUSTAINABLE AVIATION FUEL (SAF), hydrogen and electric all have a role to play in the decarbonization of aviation. SAF is vitally important as it can address decarbonization of fuel over its lifecycle, and this is now available to be used in all turbine engines including in mid- and long-range aircraft. Therefore, understanding the feedstock landscape as well as the technology pathways is integral to maximizing the production and supply of SAF.

The production of SAF starts with one of five main families of raw materials: oils and fats, sugar and cereal, municipal solid waste, wood and agricultural residue, or renewable energy and carbon (see Image 1) used to replace a proportion of the crude oil feedstock.

Each of these feedstocks uses a particular production technology, with each specific technology pathway needing approval from the fuel standard body ASTM before being commercially deployed.

There are two ways of producing SAF, with standalone units or through co-processing. Standalone units use sustainable feedstocks to produce the synthetic kerosene (SK), that is then blended with conventional jet fuel to produce SAF. While producing SAF through co-processing up to five percent sus-

Sustainable Aviation Fuel is now available with new Beechcraft turboprop and Cessna turboprop and jet deliveries.

tainable feedstocks being are processed alongside fossil feedstocks through hydro-processing in the refinery.

With standalone units the feedstock is converted in a biorefinery into SK and then certified to the relevant annex in ASTM D7566 standard. The approved technology pathways and associated feedstocks are shown in Table 2. This SK is then blended up to 50 percent with conventional jet fuel and certified to ASTM D1655 or Defence Standard 91-091 and is supplied as a conventional Jet A/ Jet A-1 fuel.

Two of the technology pathways and associated feedstocks are approved to produce SAF through co-processing. These feedstocks are shown in Table 3.

HYDROTREATED ESTERS AND FATTY ACIDS

Driven by the lower cost of capital and the availability of feedstocks which are close in energy density to fossil fuels, most of the SAF supplied today is derived using the hydro-treated esters and fatty acids (HEFA) pathway. The primary feedstocks for this conversion pathway include waste fats, oils, and greases and following pre-treatment these can be processed in standard hydro-cracker units.

While HEFA synthetic paraffinic kerosene (SPK) is currently the only commercial pathway being used at scale to produce SAF, current feedstocks are limited. There is need for rapid commercial large-scale sustainable feedstock mobilization. Alternative high energy crops that are being trialled or have already been approved as HEFA feedstocks, include algae, camelina, pennycress, tallow tree and carinata (also used in the production of plastics, lubricants, paints, and cosmetics).

Some industry players promote the use of cover crops (crops grown for the protection and enrichment of the soil), such as carinata, as a feedstock when they do not require additional land demand and contribute to sustainable farming practices – supporting soil carbon accumulation, soil quality and biodiversity. bp has already entered into a long-term strategic offtake and market development agreement with Nuseed to purchase carinata oil.

While an increasing number of flights have been fuelled by SAF produced from the HEFA pathway, limited feedstocks mean we expect to see SAF produced from alcohol to jet (AtJ), Municipal Solid Waste (MSW) and second generation (2G) biomass increasing significantly beyond 2030.

C-SAF: DECARBONIZING AVIATION INDUSTRY

THIS SUMMER, the Canadian Council for Sustainable Aviation Fuels (C-SAF) launched a roadmap detailing its policy framework, its priority actions, and the next steps to ensure that the Canadian aviation sector remains competitive as it transitions to a net-zero future by 2050. The roadmap was developed in collaboration with Energy Futures Lab and the Transition Accelerator.

Created in February 2022 by a consortium of 60 airlines operating in Canada and key stakeholders in the Canadian aviation ecosystem including suppliers, aerospace manufacturers, airports, finance, and academia, the Council aims at facilitating the production and supply of affordable, low-carbon, made-in-Canada sustainable aviation fuels (SAF). As outlined in Canada's Aviation Climate Action Plan, SAF will play an important part in decarbonizing aviation, especially for long haul aviation - which comprises the largest portion of Canadian aviation emissions in coming decades.

"Successful implementation of SAF across Canada relies on industry and government working together to reduce cost, enhance sustainability, and significantly expand production to achieve one billion litres of domestic sustainable aviation fuel in 2030," said Geoff Tauvette, Executive Director of C-SAF. "This roadmap is framed on creating a net-zero industrial policy to build sustainable and competitive SAF supply chains and clarify downstream demand while properly incentivizing carbon reduction practices at the feedstock stage."

NOW IS THE TIME: DECARBONIZING THE AVIATION INDUSTRY

Canada has enormous opportunities already in the SAF supply chain: bountiful sustainable feedstock, existing refining capacity, innovative technology providers, as well as domestic and international airlines seeking to decarbonize, which is why this roadmap is premised on a target of one billion litres of SAF by 2030. But this target, which represents 10 percent of all jet fuel use in Canada is just a waypoint on the way to net zero. By 2035, Canada should be ready to produce SAF to meet 25 percent of total jet fuel demand which would reduce emissions by 15-20 percent for departures from Canada. The first roadmap for SAF in Canada relies on three key objectives to balance:

1. Decarbonize now: maximize SAF now from commercial ready pathways.
2. Feedstock activation: establish commercial pathways for all Canada's feedstocks.
3. Innovation drive: launch demonstrations with homegrown technology in multiple pathways.

"C-SAF recognizes the urgency of the climate crisis, and we are fully committed to a sustainable future," said Tauvette. "Canada has all the ingredients to create an affordable and reliable SAF market, and it is imperative to ramp up our efforts while pursuing the development of long-term solutions such as electric and hydrogen technologies…"

Opposite page, right: Air bp produces SAF at its Castellon Refinery in Spain.

FIRST GENERATION ALCOHOL TO JET (ATJ)

Alcohol to jet (AtJ) is another technology that has an approved pathway. It is a method whereby sugary, starchy biomass such as sugarcane and corn grain are converted via fermentation into ethanol or other alcohols which can then be shipped or piped before being converted to fuel. These feedstocks are easy to grow and transport by train, however sugarcane must be processed into ethanol within 48 hours of being cut. To achieve low logistical costs, reduce carbon emissions from transport and make better use of infrastructure, ethanol plants benefit from being placed close to feedstock production mills as well as to refineries.

In some regions, particularly in the Americas, feedstock such as corn and sugarcane are currently commercially used for fuel production. Demand from sectors such as ground fuel and petrochemicals means however that there is limited feedstock available to aviation. As a result, there are no commercial SK plants using the AtJ production pathway.

Timing is therefore the important factor to consider with the AtJ pathway. As ground fuels move more towards electrification this will free up feedstock supply for the aviation sector which in turn will lead to commercial SAF production from this pathway.

Another consideration with the AtJ pathway is that the reduction in carbon intensity is not as strong when compared to the alternative technologies. Implementation of solutions such as carbon capture and storage technology will be key to

lowering greenhouse gas emissions (GHG) using this technology. Other options to evaluate include the use of biogas in place of natural gas in mills and converting farm machinery to run on biofuels rather than fossil fuels.

FISCHER-TROPSCH FOR MUNICIPAL SOLID WASTE

As with AtJ there are approved pathways for this production. There is also feedstock availability, therefore producers are focusing on technology developments that can reduce the relatively high capital costs.

For SAF produced from MSW using Fischer-Tropsch (FT) technology the main environmental gain is derived from the fact that the waste would otherwise be left to decompose in landfill sites. According to the World Bank, the world generates more than two billion tonnes of MSW annually; a figure that's expected to grow to 3.4 billion tonnes by 2050. However, while access to MSW as a feedstock is widely available across the globe and it is typically a lower cost feedstock than other raw materials, in some regions aviation is in competition with other sectors, including the energy industry, for access to MSW.

In the EU, Air bp is – among other feedstock and technology pathways – advocating for recycled carbon fuels made from the non-organic portion of MSW to be recognized as SAF under the EU's planned SAF blending mandate. Air bp is not however advocating for the use of recycled plastics as a standalone feedstock source for SAF.

The largest Japanese airlines All Nippon Airways (ANA) and Japan Airlines (JAL) have outlined plans for SAF to comprise at least 10 percent of their fuel by 2030.

Image 1

The five main feedstock families have different constraints

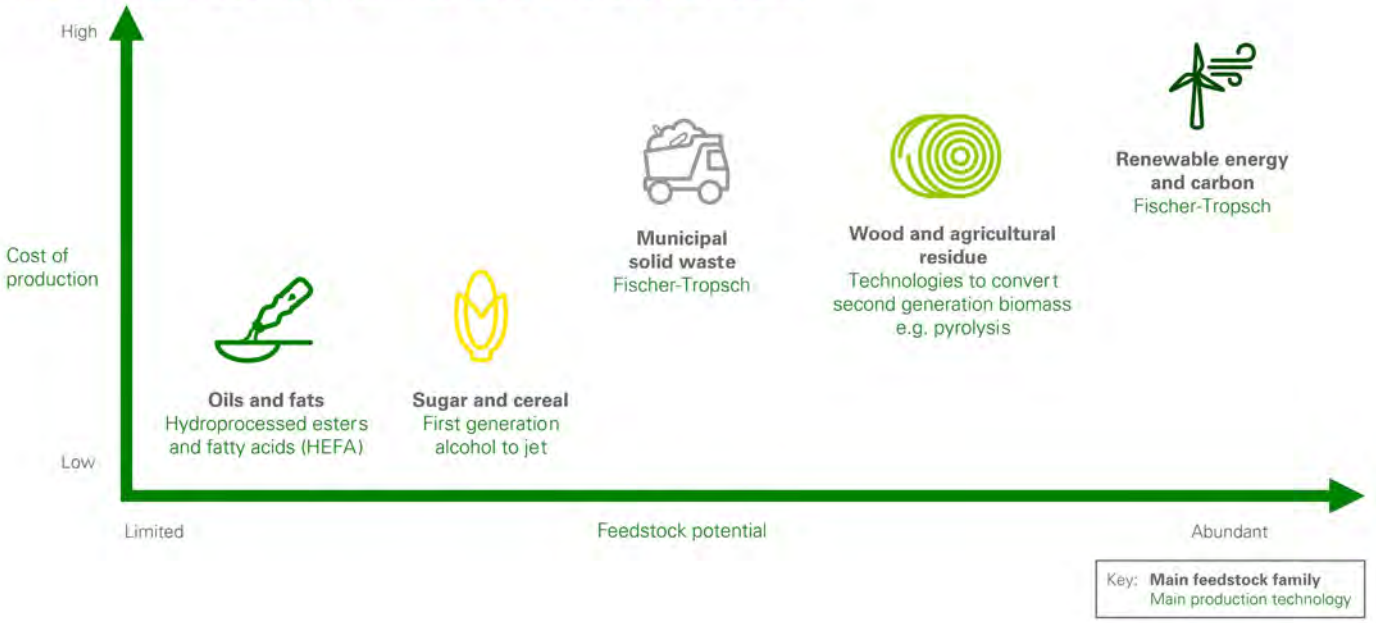


Table 2

Seven technology pathways currently certified by ASTM to produce synthetic kerosene (SK):

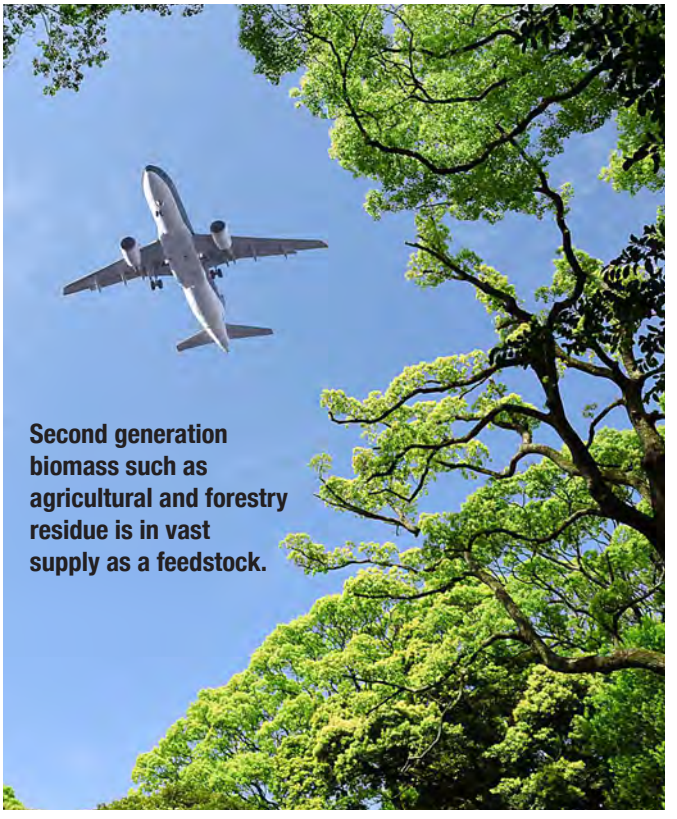
Technology	Common name	D7566 Annex	Feedstock	Max % in final product
Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene	FT-SPK	A1	Waste CO_2 and renewable power. Municipal solid waste. Agricultural waste / waste wood.	50
Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids	HEFA SPK	A2	Vegetable oils and waste oils (e.g. used cooking oil)	50
Synthesized iso-paraffins from hydroprocessed fermented sugars	SIP	A3	Fermentable sugars	10
Synthesized kerosene with aromatics derived by alkylation of light aromatics from non petroleum sources	FT-SPK/A	A4	Waste CO_2 and renewable power. Municipal solid waste. Agricultural waste / waste wood.	50
Alcohol to jet synthetic paraffinic kerosene	ATJ-SPK	A5	Ethanol and Isobutanol	50
Synthesized kerosene from hydrothermal conversion of fatty acid esters and fatty acids	CHJ	A6	Vegetable oils and waste oils (e.g. used cooking oil)	50
Synthesized paraffinic kerosene from hydrocarbons, esters and fatty acids	HC-HEFA SPK	A7	Botryococcus braunii species of algae	10

It's a capital-intensive process to get the infrastructure in place, as production includes producing an FT wax which is then refined into SK before being blended into SAF. The good news here is that there is ongoing work to research and develop technologies that will lead to more efficient production. For example, Air bp and Johnson Matthey co-developed and co-own anFT technology that can operate both at large and small scale to economically convert synthesis gas, generated from sources including MSW, into long-chain hydrocarbons suitable for the production of SAF.

TECHNOLOGIES TO CONVERT SECOND GENERATION BIOMASS

For these feedstocks there is no pathway that is commercially deployed. However, work is progressing with ASTM for pyrolysis of biomass through both standalone production and co-processing in refineries. Once a pathway is approved, demo plants would then need to be established to prove the technology at scale before it is commercially deployed.

While second generation biomass such as agricultural and forestry residue is in vast supply as a feedstock, once aggregated it must be transported by road or rail – as a solid it can't be moved via pipeline. Ultimately this means small production plants near where forestry residues are processed. While



Second generation biomass such as agricultural and forestry residue is in vast supply as a feedstock.

World Energy announced plans to convert its existing facilities in Houston to a sustainable aviation fuel hub capable of producing 250 million gallons of cleaner jet fuel annually by 2025.

Table 3

Two technology pathways currently certified by ASTM to produce SAF through co-processing

Technology	Feedstock	Max % in final product
Co-hydro processing from Fischer-Tropsch	Waste CO_2 and renewable power. Municipal solid waste. Agricultural waste/ waste wood.	5%
Co-hydro processing from hydroprocessed esters and fatty acids	Vegetable oils and waste oils (e.g. used cooking oil)	5%

a handful of these plants already exist, none are being used currently to produce SAF.

FISCHER-TROPSCH FOR POWER-TO-LIQUID

Possibly one of the most promising pathways for SAF in the longer term is power-to-liquid (PtL) technology (producing what is called eSAF), which is still very much in its infancy. Renewable electricity (from sources such as solar, hydro or wind) is used in an electrolysis process to extract hydrogen from water. This green hydrogen is first used to convert carbon dioxide (from the air, biogenic or industrial sources) to carbon monoxide. Then using FT synthesis technology, this carbon monoxide along with more green hydrogen is converted into a wax that can be upgraded to SK.

The challenge currently with eSAF technology is cost. To be commercially viable and competitive with conventional jet fuel this fuel (which is expected, in the short-term, to be three to eight times the cost of conventional jet fuel and up to around four times the cost of SAF made from HEFA) needs to be produced at low cost. The availability and cost of the renewable energy and carbon dioxide, as well as the expansion and improvement of green hydrogen plants must be addressed to meet market demand.

Carbon dioxide could be secured from existing industrial sources such as plaster, concrete and food manufacturing companies as well as direct air carbon capture (a technology which removes carbon dioxide from the atmosphere). While sectors such as the steel and cement industries continue to explore technical solutions to reduce the carbon they emit, eSAF producers can benefit from using this cost-effective carbon dioxide source.

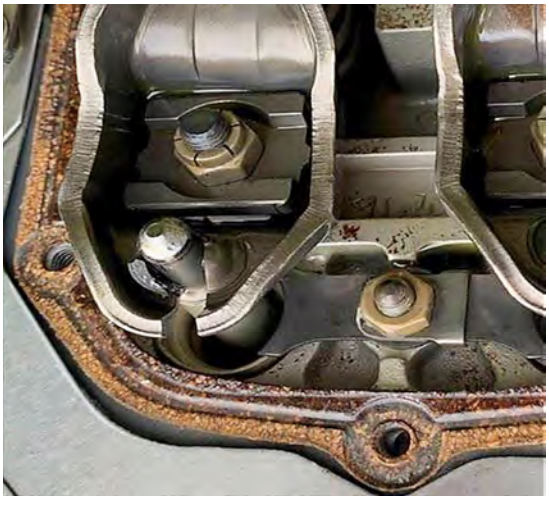
In terms of increasing green hydrogen production, as it is required by many industries to decarbonize, aviation will benefit from the focus being placed on increasing production. In addition, German mandates have specific requirements for eSAF from 2026 and European mandates currently being finalized are expected to follow suit in 2030.

Longer-term, eSAF will also benefit from on-going work in developing new pathways in addition to those already approved. In particular, methanol to jet could provide a competitive alternative production method for these feedstocks.

In summary, aviation is one of the hardest-to-abate sectors when it comes to reducing fuel lifecycle carbon emissions, with SAF currently the only way to decarbonize the industry at pace and at scale. Utilizing a wide range of feedstocks is key to the production of SAF, as is the ongoing evolution of production pathway options. Air bp says it will continue to work with stakeholders across the energy supply chain as well as governments, NGOs, authorities and other businesses to help meet future SAF demand. ■

★ TRANSPORT CANADA ★
Reports and Comments

The following are selections of Canadian Aviation Service Difficulty Reports originally published as "Feedback" by Transport Canada.



Above and right: Avco Lycoming. Rocker Arm failure at pushrod socket.

REPORT: AVCO LYCOMING O-320-H2AD

Rocker Arm Failure

Subject:

A student pilot was on a solo flight when they experienced a sudden loss of power and a rough running engine. Troubleshooting and attempting to resolve the issue was unsuccessful and the pilot was unable to maintain altitude. As such, the pilot landed the aircraft in a nearby field. They activated the ELT and completed a mayday call before touching down. Upon initial inspection there was no damage to the aircraft from the landing. The mechanical issue was quickly found to be on the cylinder #4. The intake push rod tube was bent, and the exhaust push rod broke through the rocker arm. There were approximately 240 hours on this engine since overhaul with no significant maintenance (besides required inspections) completed prior to the failure. Cylinders were new at overhaul.

Transport Canada Comments:

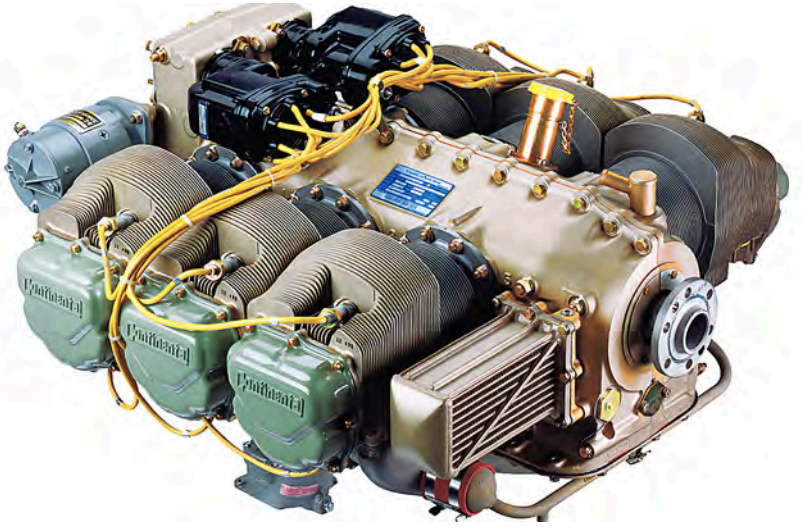
After conducting an investigation, it was found that Lycoming Mandatory Service Bulletin (MSB) 639 had not been performed at the recommended 50-hour interval following rocker arm replacement during overhaul. To prevent further incidents, Transport Canada Civil Aviation suggests that owners, operators, and maintainers incorporate MSB 639 and continue to file Service Difficulty Reports (SDRs) in the event of rocker arm defects.

REPORT: TELEDYNE CONTINENTAL O-470-R

Exhaust Valve Springs Broken

Subject:

The pilot noticed the engine running rough in flight. He returned to base and landed. Upon further investigation, the Aircraft Maintenance Engineer found low compression on the #1 cylinder and both exhaust valve springs broken. He did some research and found a report of another Teledyne Continental engine O-470 with similar problems with valve springs and subsequently decided to replace all the valve springs. At that time, he found another outer spring and 4 inner springs broken and replaced them with springs from a different supplier.



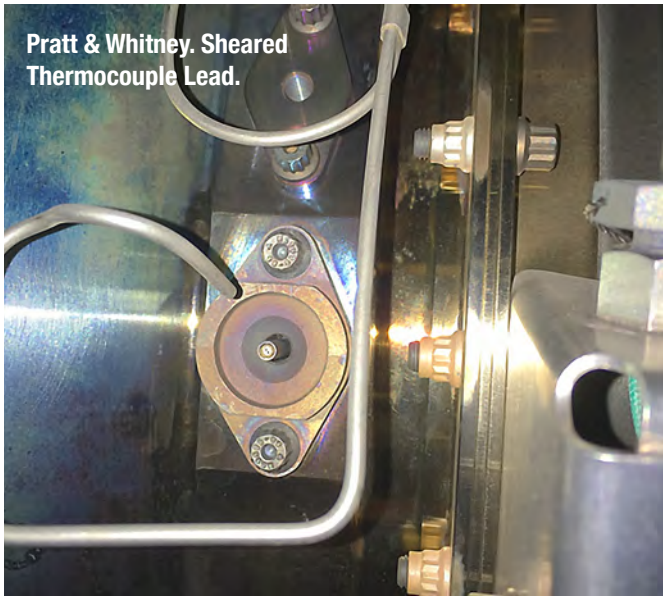
Above: Teledyne Contintental engine and springs (top left).

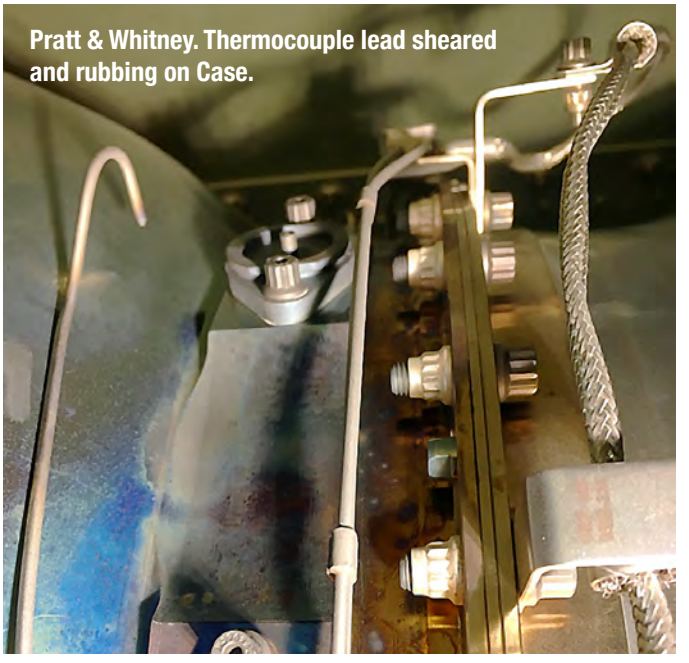
Transport Canada Comments:

Although the submitter of this event stated that they found reports of other Teledyne Continental engines with broken exhaust valve springs, a search of our service difficulty data base did not find any SDRs submitted with this Parts Manufacture Approval (PMA) part number.

PMA parts are eligible for installation on Canadian aircraft or on an aeronautical product intended for installation on a Canadian aircraft provided that the parts are marked in accordance with the part marking requirements set out by the FAA. The parts must be accompanied by an authorized release certificate which certifies that the parts conform to the applicable design data approved by the FAA or the Minister and indicates the aeronautical product for which they are eligible.

Transport Canada brings this event to the attention of operators and maintainers for awareness of a potential problem with these PMA parts. If you have experienced related problems with these valve springs on this engine model or similar models, we encourage reporting events through your SDR system for trend monitoring and possible continued airworthiness safety actions.



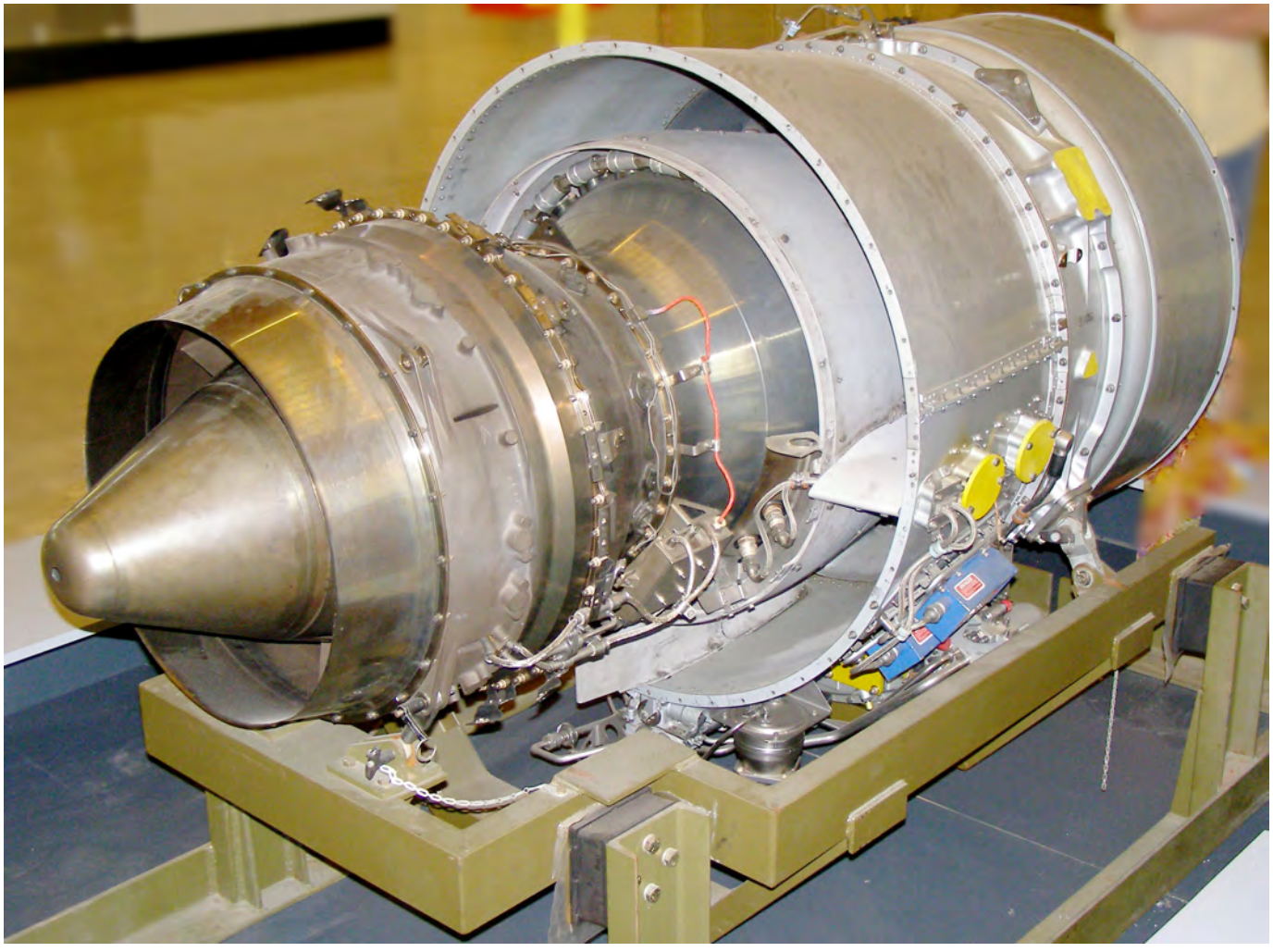


REPORT: PRATT & WHITNEY – CANADA PW306D

Broken Thermocouple Harness

Subject:

While inspecting the internal ignition lead segments to the igniter plugs, during the first 800-hour interval tasks, broken thermocouples were observed through the bypass access panel. Upon further inspection, it was discovered that there



Above: A Pratt & Whitney PW300 engine type, similar to the PW306D.

were broken probes on each wiring harness of both engines. All four thermocouple wiring harness assemblies (two per engine) required premature replacement at 818.2 hours total time since new.

Transport Canada Comments:

From the photos provided by the service difficulty report submitter, the thermocouple leads seem to have broken close to the thermocouple probe body where the assembly is attached to the engine case. Some discoloration on the thermocouple leads may indicate corrosion and the offset alignment of the lead to the thermocouple probe after breaking suggests stress or fatigue induced during installation.

The root cause of this event is still being investigated by the manufacturer, however, Transport Canada Civil Aviation (TCCA) would like to highlight this event for operators of PW306D engines and similar models. If performing inspections in this area or carrying out the 800-hour interval task, pay particular attention to the security and serviceability of the thermocouple harnesses and report any findings through the Web Service Difficulty Reporting System.

Bell Textron. Fractured lug on the swashplate inner ring.

REPORT: BELL TEXTRON 212

Fractured Lug on the Swashplate Inner Ring

Subject:

Swashplate inner ring part number 204-011-402-021 was found to have one lug broken off. It is evident that the lug was fractured for some time. Bell Helicopter has been notified of this service difficulty report. The subject parts have been placed into quarantine stores.

Bell Textron 212

Transport Canada Comments:

Bell received reports of cracked or broken lugs on the swashplate inner ring, and to raise awareness, have subsequently published Information Letter (IL) 212-22-74. The IL is addressed to owners and operators of model 204B, 205, 205B, 212 and 412 helicopters. It emphasizes the importance of the scheduled daily and 25-hour inspections (as applicable). The IL also provides a reminder of the importance of the CAUTION notice found in the disassembly instructions of the applicable Maintenance & Overhaul (M&O) or Component Repair & Overhaul (CR&O) manual. The CAUTION is a reminder that a retaining compound was used during the installation process, and that in order to prevent damage to the lug, it must be supported when driving out the bolts. To raise awareness of this service difficulty, Transport Canada Civil Aviation (TCCA) encourages the owners and operators

of the affected helicopter models to review Bell IL 212-22-74 and to remain vigilant during the inspection and disassembly of the swashplate and support assembly.

REPORT: ROBINSON R44

Loose Tail Rotor Blade Tip

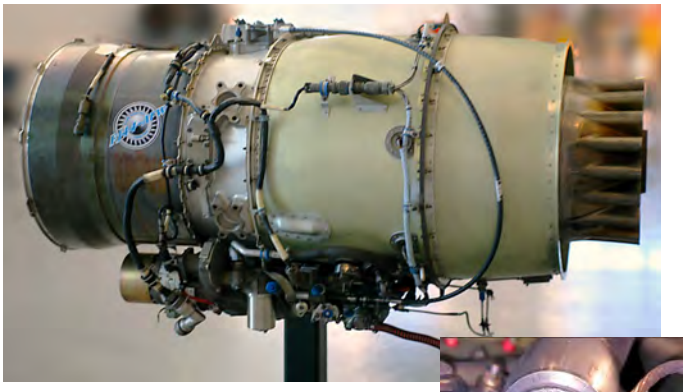
Subject:

Tail rotor tip cap debonded and was thrown from tail rotor blade shortly after landing. The bonded area of tail rotor tip cap found to be severely corroded. A tap test of bonded area (as per R44 SL-82) showed no evidence of debonding during last inspection. It was observed during testing that tap test method is not a reliable way to determine tip cap debonding. With the tip cap loosely fitted, the tap test was tried and found no change in sound between this blade and a new blade, despite having no bonding. There was a possible rotor overspeed that may have caused extra stress required to cause separation, however the pilot is unsure if the overspeed had occurred.

Transport Canada Comments:

Robinson Helicopter Company (RHC) has received reports of tail rotor blade tips coming loose. The cause of the loose tip was determined to be a debonding of the tail rotor blade tip due to corrosion. A debonded tip could cause the helicopter to experience severe tail rotor vibrations. RHC has published R44 Service Bulletin SB-112 to provide instructions for a recurring inspection and replacement of affected tail rotor blades. Transport Canada Civil Aviation recommends that R44 series helicopter owners, operator and maintainers review and accomplish SB-112.


Robinson R44.



REPORT: WILLIAMS FJ44-3A

Power Turbine Temperature Sensor and Electrical Connector

Subject:

On ground, an engine turbine temperature heater fail annunciator and an engine control system annunciator were received. After shut down, the circuit breaker for the left hand power turbine temperature heater was found open in the tail cone. Upon inspection, it was noted that the P20 electrical connector had uncoupled from the engine power turbine temp sensor and was hanging loosely within the intake structure. The P20 electrical connector`s threaded bezel had fractured into several pieces. Evidence of electrical arching was noted on the J20 and P20 electrical connectors. The body of the failed sensor appeared to be swollen when compared to a serviceable unit. Additionally, it was observed that one of the sensor`s three mounting bolts had pulled through the isolation grommet. Research of the technical records show no maintenance had been performed on the sensor.

Transport Canada Comments:

Transport Canada is bringing attention of this event to operators and maintainers of the Williams FJ44-3A and to similar models.

The photos attached show the extent of several failed components of the power turbine temperature sensor system. The electrical connector plug P20 may have disconnected because of the damaged threaded bezel fracturing therefore not being secured to the receptacle J20, however why it fractured could be the result of the sensor itself which appears to have overheated and distorted its shape. This distortion may also have caused the mounting bolt and grommet to pull out of the mounting bracket.

TC would like to remind operators and maintainers to pay particular attention to this sensor and connector when inspecting in this area and note of any findings by reporting them through their SDR reporting system. ■

PACIFIC

Pacific AME Association

Mission Statement

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

We shall promote honorable practices among our Members and others in the aviation industry, while remaining non-union, non-sectarian and non-partisan.

Formal Transfer

PAMEA has decided to formally transfer Membership Administration to AMEC/TEAC which is currently handled by the Ontario Association. What this means for the Membership is that our web site page will send you to the Ontario Association Membership pages for you to Sign Up if you are a new Member or to complete your renewal as a PAMEA Member.

What this means for the future is more time to concentrate on Conferences; more time to communicate to members through a Monthly Newsletter; more time to deal with your issues.

www.amec-teac.ca/pacific

WESTERN

Western AME Association

Who We Are

The Western Aircraft Maintenance Engineers Association (WAMEA) is an organization equipping its members with the knowledge and professionalism which distinguishes the occupation of Aircraft Maintenance Engineers (AMEs) in the aviation industry.

For any inquiries email, info@wamea.com
or email, president@wamea.com
Phone: 587-713-WAME (9263)
http://www.amec-teac.ca

CENTRAL

Central AME Association

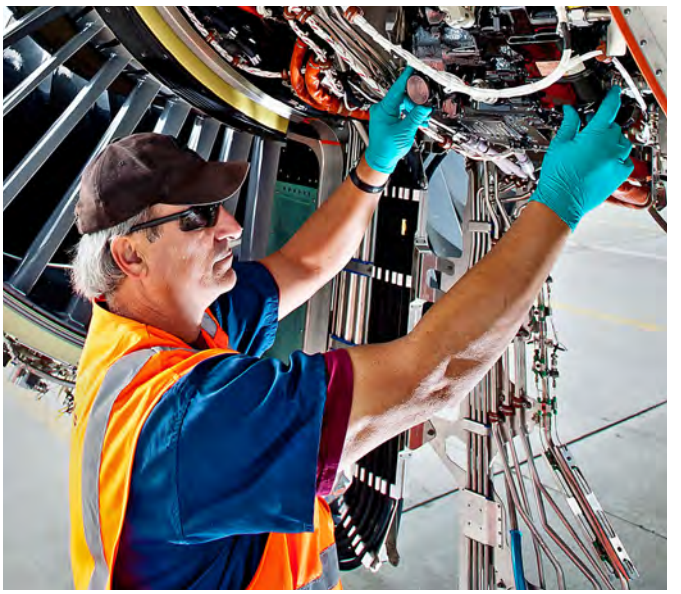
About CAMEA

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. Our chapter is one of six similar associations across Canada who collectively support the national body AMEC-TEAC (Aircraft Maintenance Engineers of Canada).

Our organization works with Transport Canada in the formulation of new rules and regulations and provides a collective viewpoint for all AME's.

CAMEA is a not-for-profit organization run by a volunteer group of AME's. We elect members of our organization to be part of our Board of Directors. Members of CAMEA are comprised of AME's, AME apprentices, students, non-licensed persons working in the industry and corporate members.

www.camea.ca



AME Association of Ontario

#613 - 7360 Bramalea Road, Mississauga, Ontario L5S 1W9
tel: 1-905-673-5681 email: association@ame-ont.com website: www.ame-ont.com

ONTARIO

Skills Development Fund Project

In Toronto, the Labour Day Weekend CIAS-CNE-2023 airshow was a huge success for our AME-Ont Skills Development Team Project. Our team had over 650 "walk-ups" to the Outreach tent/booth. Curious individuals were treated to hands-on demonstrations of aircraft maintenance presentations with examples of lock-wiring through how aircraft piston and jet engines work.

The second weekend of September saw our display move to the LONDON "Forest City" Airshow. Again the team was on hand promoting the aircraft maintenance profession and bringing the information about the need for skilled aircraft maintenance personnel to the attention of the public. They passed out brochures promoting the programs offered by the six Ontario colleges that offer aircraft maintenance degrees and answered questions about our industry.

Check our AME Association social media sites for more events as the SDF team visits high schools and job fairs throughout the province.

Annual Conference and Workshop

Transport Canada Civil Aviation (TCCA) will be at our 50th Ontario Aircraft Maintenance Conference November 29 & 30, 2023 to answer any of your questions. We will also have more than fifty companies with booths and displays. Our annual Skills Competition will be running concurrently with the conference.

Two full days of training and information sessions are planned covering manufactures products, soft skills training, as well as the latest regulatory information and updates. On line information and registration is available at the association website.

Our conference is being held at the Delta Hotel and Conference Center 655 Dixon Rd, Toronto, ON M9W 1J3. This year's theme is "The Future of Aircraft Maintenance - Performance, Professionalism and Pride".

See more at: www.ame-ont.com/cpages/conference-2023

Submitted by ***Stephen Farnworth,***
For the Board of Directors
www.ame-ont.com

Quebec AME Association

Association des Techniciens/Techniciennes d'Entretien d'Aéronefs du Québec

C.P. 34510, 3131 Côte-Vertu; CSP Place Vertu, Saint-Laurent, Qc, H4R 2P4
email: info@ame-tea.com website: www.ame-tea.com

QUÉBEC

Nous sommes l'Association des Techniciens et Techniciennes d'Entretien d'Aéronefs du Québec et nous sommes fiers de pouvoir servir et promouvoir la communauté des TEA du Québec. Membre de l'AMEC/TEAC, nous travaillons avec les différentes associations de TEA à travers le Canada sur différents dossiers, dont certains directement avec Transports Canada.

L'Association des TEA du Québec promeut la sécurité des personnes affectées par les métiers de la maintenance aéronautique, favorise des pratiques sûres sur le lieu de travail et reconnaît que la sécurité est la pierre angulaire de l'industrie aéronautique.

Nous avons récemment été actifs à différents niveaux et avons eu le plaisir de participer à la journée Carrière de l'École nationale d'aérotechnique de St-Hubert le 29 mars et avons eu la chance d'y rencontrer nombre de futurs TEA. Plus de 43 compagnies qui emploient des TEA au Québec y étaient présentes. Notre présence permet aux étudiants d'en apprendre plus sur les aléas du métier et de ce qui les attend lors de leur premier emploi. Aussi, plusieurs nouveaux étudiants profitent de cette journée pour faire le plein d'informations. L'Association des TEA du Québec continue la progression de différents dossiers tels que diverses questions de nos membres relatives à la réglementation et la recherche de nouveaux avantages pour eux avec différents partenaires. Vous pouvez en apprendre plus à notre sujet à l'adresse suivante : **www.ame-tea.com email: info@ame-tea.com**

About Us

The association's mission is to represent all AMEs in Quebec regardless of the company or the contracts on which they work. Regardless of the type of aircraft on which the AME works, he/she will be welcome. We will simply recognize ourselves as a holder of an AME Transport Canada M1/2, E or S license with an attachment in Quebec.

The Association will ultimately become the AME's voice to Transport Canada's ears and will work with existing AME associations from coast to coast to make our profession stronger and more cohesive. One of the great goals of our association is to elevate ourselves to the status of a professional and to be recognized as such by the various federal government bodies. The other major mission of our association will be to make our profession better known to the public and to get involved with young people so that they know what AME's work is and consider it as a career choice.

Visit : **www.ame-tea.com email: info@ame-tea.com**

ATLANTIC

Atlantic AME Association

Sign the petition

Aircraft Maintenance Engineers of Canada / Techniciens d'Entretien d'Aéronefs du Canada (AMEC/TEAC) have petitioned the Canadian House of Commons to have April 20th officially recognized as 'AME Day' in Canada. This date is a significant date for AMEs in Canada, as it was this day in 1920 when Canada's very first Air Engineer licence (predecessor to the Aircraft Maintenance Engineers licence) was issued to Robert McCombie of Regina, Saskatchewan.

All of the Canadian Regional AME Associations have signed the original request for this petition to be put forward and we are now asking for your support in getting this petition presented to the House of Commons, so that the Government of Canada will recognize the work the AME does to keep the Canadian Aviation Industry moving for the people of Canada.

To sign, follow this link:
https://petitions.ourcommons.ca/en/Petition/Details?Petition=e-4405

By e-signing this petition, we will be closer to having AME recognized as a profession worthy of national recognition. Thank you for your help with this petition.

www.atlanticame.com

SOCAL

SoCal PAMA Chapter

Flight Safety Detectives podcast:
Episode 181 UAPS pose flight safety threats

People have seen unexplained objects in the skies for decades. The US Government and other entities are finally discussing these events publicly, an important development for aviation safety.

"These events have an impact on flight crews and systems and are important to look at," says Todd Curtis, on the Flight Safety Detectives podcast.

Now falling under the classification, unidentified anomalous phenomena (UAP), these events have been cited by the US Government as impacting national security and public safety. Todd and John discuss how these events impact aviation safety.

The episode looks at the July 2023 hearing in the US House of Representatives that included testimony from three military veterans who either witnessed or investigated UAP events. John and Todd share their perspectives on the aviation safety aspect of UAP issues, including the difficulty of understanding what may be behind these phenomena when there are few trustworthy sources of information.

Who We Are

The purpose of SoCal PAMA is to promote a high degree of professionalism among aviation maintenance personnel; to foster and improve methods, skills, learning, and achievement in the field of Aviation Maintenance; to conduct local meetings and seminars; to publish, distribute, and disseminate news, technical bulletins, journals, and other appropriate publications dealing with the trade of Aviation Maintenance; to collaborate with other organizations in aviation in the queries of governmental agencies pertaining to maintenance rules and guidelines.

www.socalpama.org

Central Ohio PAMA

Flight Safety Detectives:
Episode 181 Aviation thrill seekers beware

On the Flight Safety Detectives podcast. Todd Curtis, Greg Feith, and John Goglia discuss the risks of aviation thrill-seeking. They look at aviation disasters from the NTSB database that involve experiences outside of standard FAA regulations.

The FAA allows certain commercial operators to offer voluntary high-risk experiences to the general public. "Top Gun" aerobatic rides, balloon flights, and sight-seeing flights are some examples. Existing rules allow for a wide range of leeway in FAA approval for these types of flights. Oversight may be minimal.

They evaluate a plane crash where a thrill ride resulted in the loss of the aircraft and crew. The high-impact collision occurred in Four Corners, California.

Anyone considering one of these experiences needs to consider the aviation safety risks involved. Thrill seeking can be a deadly experience.

John and Greg also share insights from AirVenture 2023, including new safety products from various manufacturers and concerns about the insurance needs of older pilots.

Be a content contributor

Our members work at many airports in the Central Ohio area and may be interested in some event happening at your airport. This information might include visiting vintage aircraft or dignitaries, fly-ins, airshows, etc. If you know of some upcoming event or special interest item at your airport, pass us an email including some base information and we'll post it here for other members to view.

www.copama.org

Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

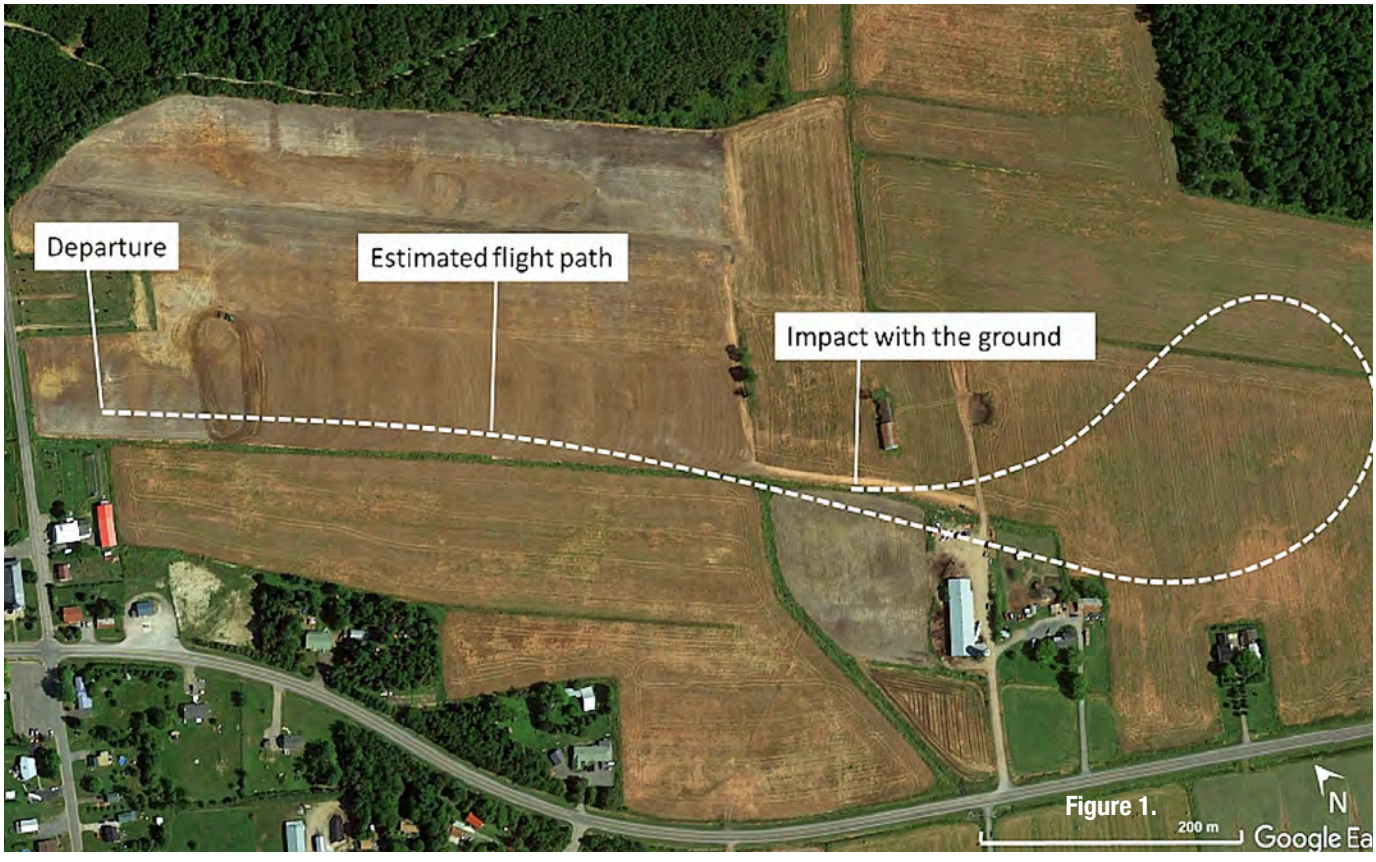
Figure 2.
Occurrence aircraft, photo taken in 2011.

Trouble lies Skin Deep

When a main rotor blade assembly breaks up, evidence points to the unqualified owner/maintainer of an amateur-built helicopter.

At **AROUND 12001 ON 29 NOVEMBER 2022**, the owner/pilot of the amateur-built RotorWay Exec helicopter (unregistered, serial number RBB1996) pulled the aircraft out of his garage in the Municipality of Lefebvre, Quebec, with the assistance of a family member. The pilot intended to conduct a local visual flight rules flight from the private field beside his garage.

The pilot, who was alone on board, started the engine and let it run for approximately 10 minutes. He then brought the helicopter into a hover less than 1 m above the ground and continued to hover for approximately 30 seconds. The family member who had assisted the pilot was filming the aircraft with his cellphone. The pilot then climbed, flying along the field in a southeasterly direction over an estimated distance of approximately 0.5 nautical miles (NM) before turning back toward his point of departure.



According to an analysis of the video, the flight took place at a maximum height of approximately 154 feet above ground level. On the way back, the pilot began a descent and, shortly afterwards, fragments separated from the aircraft as the aircraft began to break up in flight and drop. Approximately 2 minutes after takeoff, the aircraft struck the ground at a steep angle and ended up in a ditch marking the boundary of a field approximately 0.3 NM southeast of the point of departure (See figure 1, above).

Emergency services were notified of the crash, and first responders arrived at the accident site shortly afterward. The pilot was fatally injured. The aircraft was destroyed by the impact forces, and there was no post-impact fire. The aircraft was not equipped with an emergency locator transmitter.

Top of page: Figure 1.
Satellite photo showing the estimated flight path.

Opposite page, bottom: For amateur-built aircraft, as well as for owner-maintained aircraft, the person who performs the maintenance is not required to hold an aircraft maintenance engineer licence.

PILOT INFORMATION

The pilot held a Canadian airline transport pilot licence – aeroplane and a Category 1 medical certificate, both of which were valid. He held the following ratings: single-engine and multi- engine (landplane and seaplane), Group 1 instrument flight, and Class 3 instructor.

He did not have a Transport Canada helicopter pilot licence and was not authorized to exercise the privileges of such a licence. There was no indication that the pilot had completed any training flights with a qualified flight instructor as a helicopter student pilot. The pilot's personal log could not be found.

AIRCRAFT INFORMATION

The aircraft, an amateur-built 2-seat, 2-bladed RotorWay Exec helicopter (Figure 2), was equipped with a 150 hp 4-cylinder RotorWay RW152 liquid-cooled engine. The aircraft had been registered for the first time in March 1996 (registration C-FXOA). The certificate of registration was cancelled on 24 July 2018 by the owner at the time. According to information gathered, the occurrence pilot reportedly acquired the occurrence helicopter in July 2018, but Transport Canada did not

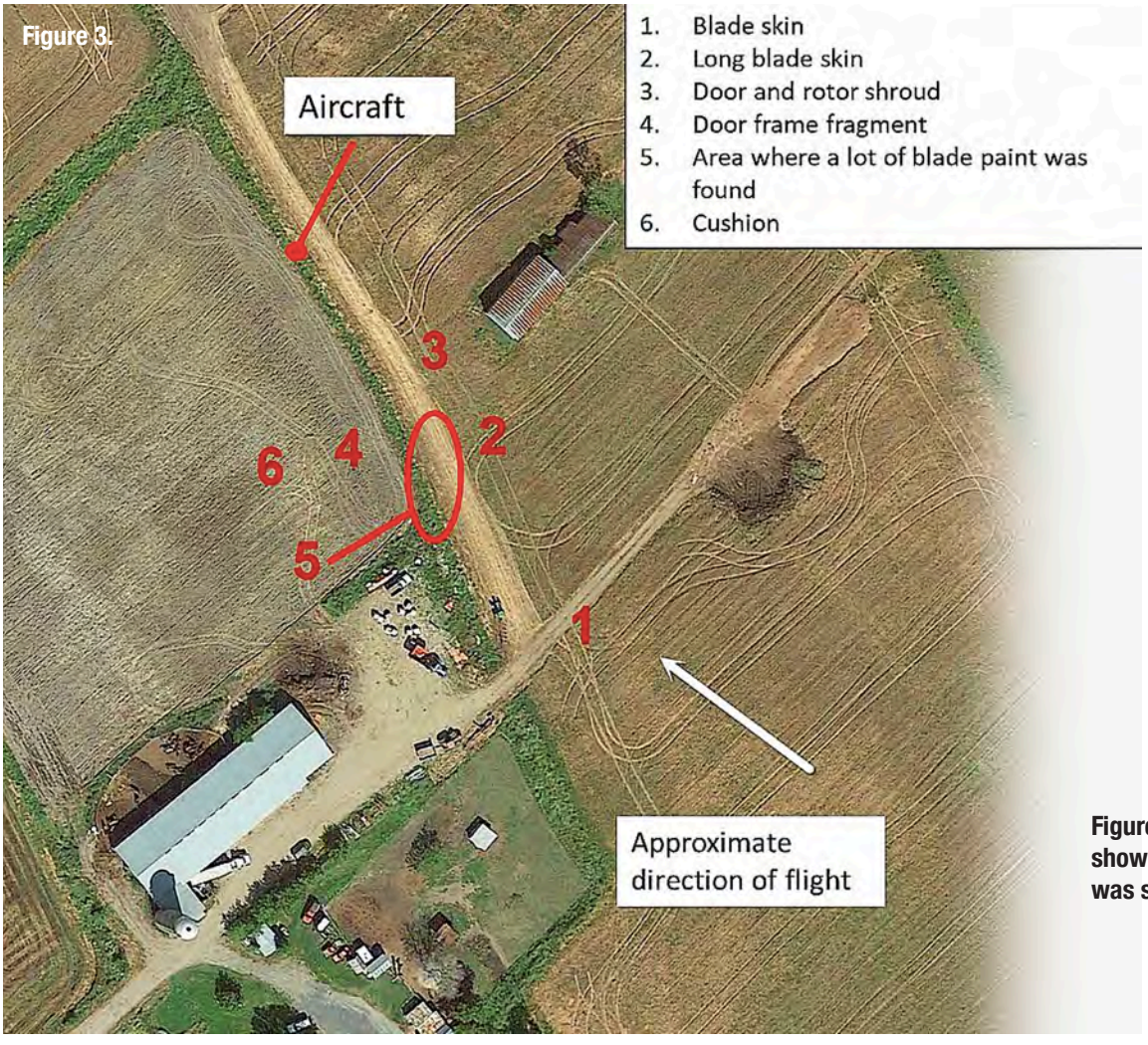


Figure 3. Satellite photo showing where the debris was scattered.

receive a registration application for this aircraft; therefore, it had not been registered since July 2018.

When the flight authority was issued, the aircraft had an empty weight of 970 pounds and a maximum take-off weight of 1500 pounds.

In July 2018, when the occurrence pilot purchased the aircraft, the hour meter read 256 hours. At the time of the occurrence, the hour meter read 310.5 hours.

ACCIDENT SITE AND EXAMINATION OF THE WRECKAGE

The aircraft was lying on its left side in a ditch between 2 fields. The tail boom was fractured, but was still attached to the fuselage by the tail rotor control cable and electrical wiring. Ground impact marks were observed approximately 6 m southwest of the fuselage.

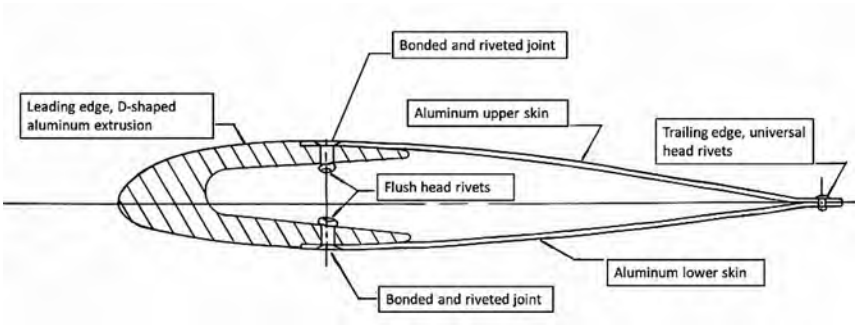
One of the 2 main rotor blades was still in one piece and showed damage consistent with that caused by the impact that had occurred. However, the aluminum skins on the upper and lower surfaces of the 2nd blade were missing. The leading edge of the 2nd blade was still attached to the rotor head and showed no signs of having struck a bird or object in flight. Several fragments of the main rotor blade skin were found southwest of the wreckage, with the furthest being approximately 116 m from the point of impact (Figure 3). The cockpit doors and roof broke off in flight and were found between the aircraft and the furthest blade fragment.

Flight control continuity between the cockpit and the main rotor was confirmed, and the blade pitch could move freely. The tail rotor blade pitch could also move freely, but control continuity could not be confirmed because of the damage.

AIRCRAFT MAINTENANCE

All aircraft must be maintained in accordance with a maintenance schedule that lists the scheduled inspections to be carried out. The depth of these inspections must be "consistent with the general condition and operating role of the aircraft." A maintenance schedule must be approved by the Minister except when the owner of a small aircraft that is not being used for commercial operations decides to comply with appendices B and C of CARs Standard 625.

One of the requirements in Appendix B that refers to the



Above, For amateur-built aircraft, maintenance instructions may have been published by the kit provider.

Left, Figure 4. Cross-sectional view of a main rotor blade.

performance of maintenance states that "[t]he method of inspection for each item on the maintenance schedule shall be in accordance with the manufacturer's recommendations or standard industry practice."

For amateur-built aircraft, as well as for owner-maintained aircraft, the person who performs the maintenance is not required to hold an aircraft maintenance engineer licence. However, according to the information note in Standard 571, which provides clarification on section 571.02 of the CARs, "[p]ersons who perform maintenance or elementary work are required to follow the manufacturer's recommendations, or equivalent practices."

For amateur-built aircraft, maintenance instructions may have been published by the kit provider. These instructions could serve as the basis for a manufacturer (the person who builds the aircraft) who decides to develop specific recommendations. The person who performs the maintenance must also meet CARs requirements with respect to technical records by documenting all maintenance actions in these records.

In this occurrence, the manufacturer had not developed specific recommendations; however, the kit provider's Airframe Information & Operations Material Manual contains pre- and post-flight checklists as well as a list of the types of operations to avoid because they may be detrimental to blade life. The person inspecting the blades must ensure, among other things, that there is no separation between the leading edge and the upper and lower skin, and that the blade tip end plugs are secure.

The investigation was unable to determine whether the pilot was familiar with and had followed the kit provider's instructions or other maintenance requirements.

MAIN ROTOR BLADES

Asymmetrically shaped main rotor blades consist primarily of 2 aluminum skins bonded and riveted to a D-shaped aluminum extrusion, which forms the leading edge. The skins are riveted and bonded together where they overlap to form the trailing edge. The blades are hollow; they do not contain any honeycomb structure or filler material (Figure 4).

The technical examination of the blade fragments and the video showing the start of the accident sequence helped to determine that the joint between the leading edge and the skin had separated, resulting in the complete separation of the

Left: Unlike most U.S.-designed helicopters, the main rotor on the Exec 162F rotates clockwise.

Below: The RotorWay Exec is a family of American two-bladed, skid-equipped, two-seat kit helicopters, manufactured by RotorWay International of Chandler, Arizona and supplied in kit form for amateur-construction.

skins and the loss of control of the aircraft by the pilot.

After a thorough examination, it was determined that the helicopter experienced an in-flight breakup of one of its main rotor blade assemblies. There was no pre-existing damage to the skins themselves, although the skin bond lines exhibited significant areas of adhesive failure.

It is most probable that the adhesive failures on both the upper and lower skins near the leading edge of the rotor tip allowed the high tip aerodynamic loads to force the skins from the main spar. A subsequent loss of torsional stiffness allowed the blade spar to deflect, causing the complete loss of both the upper and lower skins.

OTHER SIMILAR OCCURRENCES

The investigation uncovered 2 other occurrences involving RotorWay Exec helicopters and conditions similar to those of this occurrence. The first occurrence took place on 28 March 1992 in Coalport, Shropshire, United Kingdom. The investigation by the United Kingdom's Air Accidents Investigation Branch determined that the lower skin of one of the main rotor blades had delaminated and separated from the leading edge in flight, which caused the pilot to lose control of the helicopter. The delamination near the blade tip had been caused by water infiltration. Deficiencies were identified with the pre-flight inspections and storage.

The 2nd occurrence took place on 02 October 1992 in Wimberley, Texas, United States. According to the U.S. National Transportation Safety Board, delamination of the skin on one of the main rotor blades was a probable cause of the accident.11 However, the cause of the delamination could not be determined.

SAFETY MESSAGES

Owners and pilots of amateur-built aircraft and of owner-maintained aircraft must ensure that they fully understand the regulations and that they have all technical data applicable to their aircraft, including data from the kit provider, the manufacturer, and the component manufacturer. They must also ensure that all maintenance activities, including inspections, and operating procedures comply with these technical data to ensure that the aircraft remains airworthy. ■

(These were excerpts from Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 21 June 2023. It was officially released on 04 July 2023.)

It's called Industry 4.0 and it's shaping the future of Aviation maintenance and flight operations through the adaptation of evolving technology.

The Fourth WAVE

Above: Prognostic algorithms aim to forecast remaining useful life and time to reduced capability.

Right: Collaborating with Microsoft is Rolls-Royce, whose engine health monitoring service currently monitors 13,000 engines in service on approximately 9,000 commercial flights per day.

ALTHOUGH IT IS STILL DOMINATED BY MANUAL LABOUR and subjective assessments, the aviation industry has been evolving rapidly, with technological advancements driving significant changes in aircraft design, production, and maintenance. These changes are inline with the global movement called Industry 4.0—also known as the fourth industrial revolution—which is characterized by the integration of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics in the manufacturing industry. Here are some thoughts about how Industry 4.0 is specifically transforming the aviation industry through the application of smart maintenance, digital twin technology, advanced manufacturing, and augmented reality.

Airbus made a small-sized pilotless aircraft using 3D printing.

SMART AIRCRAFT MAINTENANCE

Industry 4.0 principles are being used in the aviation industry to improve maintenance processes. Smart aircraft maintenance is a key application of Industry 4.0 in aviation, and it involves using data analytics and IoT to improve the efficiency and effectiveness of maintenance processes. Smart maintenance includes predictive maintenance, remote monitoring, condition-based maintenance, and augmented reality for maintenance workers.

The application of Industry 4.0 principles to smart maintenance in aviation has the potential to improve maintenance processes, reduce downtime, and improve aircraft reliability. The use of sensor technology and data analytics to monitor aircraft components and systems in real-time are cases in point.

For example, General Electric Aviation uses this technology to monitor the performance of aircraft engines and predict maintenance needs. The ultimate goal is to prevent downtime, identify root causes for follow-up action, and enable efficient evidence-based maintenance planning and optimization. The primary research topics being pursued by GE fall into two categories: Early Warning and Prognostics.

Early Warning pertains to detecting anomalous behaviours in a system's operation at the earliest possible time, regardless of the operational mode or context that the system is operating in. The intent here is to provide the maximum lead time for any potential action, with additional technologies brought to bear once sufficient evidence exists to suggest potential problems. This technology is applicable across industrial verticals and is traditionally the first item in combined Prognostics Health Management (PHM) deployments.

GE Research software solutions for Early Warning are built around unsupervised, semi-supervised, and fully-supervised data exploration, enabling a broad span of solution complexities based upon the availability of ground truth feedback regarding normal and abnormal asset operations. As part of this, research has included an emphasis on fusion algorithms to integrate alerts and mixed-type information from multiple models to improve prediction accuracy and lead detection time as well as reduce alert fatigue. Similarly, research activities have yielded a robust multivariate ti me series search pipeline to speed up human interaction when searching for signatures, features, and patterns in massive time series data (for root cause and diagnostic reporting).

Prognostics go a step further to provide long term predictions of behaviour and life. Taking over once Early Warning has occurred, Prognostic algorithms aim to forecast remaining useful life, time to reduced capability, and emergent fleet segmentation for planning inspection, maintenance, repair, and spare parts inventory. GE Research technologies in this space are built upon a suite of hybrid modelling techniques that use embodied domain physics along with condition monitoring data from fielded systems and simulations. This

GE's Prognostics provide long term predictions of behaviour and life.

also allows learning systemic behaviours from entire fleets through techniques such as transfer learning. Furthermore, auto-inspection technologies allow for the inspection and labelling of component condition (and quantify performance of associated prognostic models) without human bias, adapting the fielded models in a continuous learning mode.

DIGITAL TWIN TECHNOLOGY

Rolls-Royce describes Digital Twins as virtual replicas of physical devices, products or entities created by combining data with machine learning and software analytics to create digital models that update and change alongside their real-life counterparts. For Rolls-Royce this means creating virtual copies of its engines.

A Digital Twin will continuously learn and update itself using data from sensors that monitor various aspects of the real-life product's environment and operating conditions. It can also factor in historical data from prior usage.

In engineering terms, the use of Digital Twins reduces the need to rely on probability-based techniques to determine when an engine might need maintenance or repair. Rolls-Royce engineers create a Digital Twin of an engine, which is a precise virtual copy of the real-world product. They then install on-board sensors and satellite connectivity on the physical engine to collect data, which is continuously relayed back to its Digital Twin in real time. The twin then operates in the virtual world as the physical engine would on-wing and will determine how the engine is operating and predict when it may need maintenance. This also allows engineers to enact preventative engine maintenance, which can greatly reduce aircraft downtime and, in turn, enhance reliability.

The data analysis used by the Digital Twin allows engineers to model a greater number of potential circumstances than physical engine tests would ever allow, which results in a greater understanding. Using a Digital Twin, engineers can study and predict the physical behaviours that an engine would exhibit under very extreme conditions. This creates the ability to model potential operational scenarios entirely digitally.

ADVANCED MANUFACTURING

Industry 4.0 emphasizes the use of advanced manufacturing technologies such as additive manufacturing (3D printing) which involves using a raw form of composite and depositing layer-on-layer. The 3D printers most people know involve plastic. The printer heats plastic until it is soft enough to mold into the desired shape, then hardens when cooled down. Advanced manufacturing, however, involves materials that have been designed to meet specific objectives.

Instead of a plastic polymer, advanced composites are used to create the component(s), which is accurate up to 0.5mm. GE Aviation, for example, uses 3D printing to create fuel nozzles for its LEAP engine, which powers the Boeing 737 MAX and Airbus A320neo.

Although it is still dominated by manual labour and subjective assessments, the aviation industry has been evolving rapidly.

Northrop Grumman says it uses five different additive manufacturing materials in its products because while polymers are a cost-effective option for many applications, in scenarios such as supersonic aircraft that get hotter than 300 degrees Fahrenheit, a metal such as titanium is often the right choice. The first 3D-printed titanium airplane part to ever fly off an aircraft carrier was built by Northrop Grumman in 2011.

Carbon fibre reinforced 3D printing has proven ideal for situations when there's a need for a low volume of something with high quality without time for conventional tooling. It has incredible strength to weight properties and remains close to rigid until failure, in which case it often fractures or splinters. It's best used in constant loading conditions when you want to match the strength of metal at a fraction of the weight, since it behaves like 6061 aluminum.

For example, users could quickly manufacture a piece of ground support equipment or aircraft parts such as linkages, brackets, bearings or cockpit panels. Also, 3D print composite

For airlines, keeping their aircraft in hangars for Maintenance, Repair, and Overhaul for longer periods costs them heavily.

parts can be printed for supporting structures in hydraulic systems and electrical systems. It's also useful for quickly replacing small parts on an aircraft's exterior that wear out often, such as boundary layer dams, vortex generators and other small aerodynamic enhancements.

Airbus uses 3D printing to produce brackets and other small parts for its A350 XWB aircraft, and by doing so has been able to reduce the weight of these parts by up to 55 percent, resulting in fuel savings and reduced emissions.

Even NASA uses this manufacturing technology when unique and strengthened components are needed. The process may take some time, depending on the component size. However, it allows for more innovation as it is cost-effective and versatile. To make changes, engineers only need to add a few nodes into the AutoCAD file and start printing. The material used can be recycled (after re-processing it).

AUGMENTED REALITY

Many industries, including the aerospace industry, have been reshaped by augmented and virtual reality. Essen-

tially, AR overlays digital information on the user's real-world view, enhancing their perception of the environment, thus offering numerous advantages in visualizing navigating systems, air traffic control, weather, terrain, and airspace information.

On the other hand, Virtual Reality is a technology that transports the user into a completely digital environment such as VR simulators to practice various scenarios in a safe and realistic environment, without the need for an actual aircraft.

For airlines, keeping their aircraft in hangars for Maintenance, Repair, and Overhaul (MRO) for longer periods costs them heavily. Every airline wants all their aircraft to fly as much as possible to increase their revenue. Remote maintenance assistance is now a possibility for companies. TAE, an Australian engine MRO company, identified the need for AR technology and developed Fountx, a wearable Augmented Reality device that allows remote experts to assist on-field technicians in real-time from anywhere.

Augmented Reality devices include high-speed processors, input devices (camera or webcams), various types of sensors, and display units (smartphones, handheld devices, smart glasses, or head-mounted displays). These are

Right: Rolls-Royce describes Digital Twins as virtual replicas of physical devices.

incredibly small components bundled into a comfortable wearable gadget. These gadgets require a considerable amount of processing power and include components such as a CPU, flash memory, RAM, GPS, GPU, Wi-Fi, and Bluetooth. Many sensors, such as an accelerometer, infrared sensor, and gyroscope are attached to the device to convey the user's interaction with real-world things to the processors.

Latest Qualcomm Snapdragon XR (XR1 and XR2 5G) systems deliver powerful computational capability to enable immersive Augmented and Virtual Reality features and devices. This platform provides immersive audio and visual solutions to devices in various industries, such as entertainment, education, the industrial sector, and others.

Businesses globally have understood the importance of AR and VR. The global augmented reality, virtual reality, and mixed reality market is expected to exceed USD 250 billion by 2028, up from around USD 28 billion in 2021. Seemingly, this is just the beginning of a completely new era in aviation maintenance and flight operations. ■

(With files from Aeronautical Engineer JC Wanja, and Samir Khan, author of Towards MRO 4.0: Challenges for Digitalization and Mapping Emerging Technologies)

Aviation Services

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De Havilland unveils new Twin Otter

A Canadian classic is reinvigorated by a fifth generation

IT WAS AT THE PARIS INTERNATIONAL AIR SHOW IN JUNE, where De Havilland Aircraft of Canada Limited announced the launch of its DHC-6 Twin Otter Classic 300-G with combined purchase agreements and letters of intent totalling 45 aircraft.

"For over 50 years, the DHC-6 Twin Otter has stood alone as the most reliable and versatile aircraft in its class," said Brian Chafe, CEO of De Havilland Canada. "After extensive consultation with our customers, we are poised and proud to take this iconic aircraft to new heights with the new DHC-6 Twin Otter Classic 300-G."

With the same airframe DHC-6 Twin Otter, propelled by Pratt & Whitney engines, the lighter weight Classic 300-G will deliver increased payload range and decreased operating costs for its customers, says the company. It will feature an all-new cabin interior and flight deck with a fully integrated Garmin G1000 NXi avionics suite.

"De Havilland Canada continues to shape aviation with innovative utility aircraft, and we are proud to offer our G1000 NXi integrated flight deck with the latest version of the iconic DHC-6 Twin Otter," said Carl Wolf, Garmin Vice President of Aviation Sales and Marketing. "The G1000 NXi will bring wireless cockpit connectivity, enhanced situational awareness, visual approach capability, and our fully integrated GFC 700 autopilot with envelope protection to the Classic 300-G aircraft."

The Classic 300-G is the fifth generation of the Twin Otter aircraft, joining the current Series 400. All DHC-6 Twin Otters carry passengers, transport VIPs, move cargo, conduct medivac operations, and perform special missions in the world's most unforgiving environments. When mounted on amphibious floats, these aircraft are capable of moving efficiently between paved surfaces and water-landing areas.

Over the course of the Paris International Air Show, De Havilland Canada announced Purchase Agreements with its Twin Otter Classic 300-G launch customers. The company says the launch of the DHC-6 Twin Otter Classic 300-G will bolster the local economy by creating 80 and 91 permanent production jobs in Calgary, Alberta and in Victoria, British Columbia, respectively. ■

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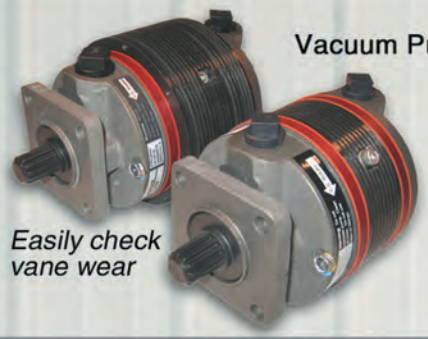

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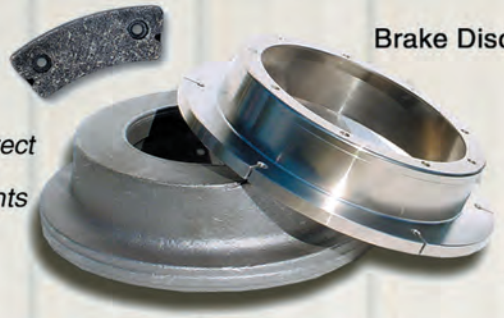

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