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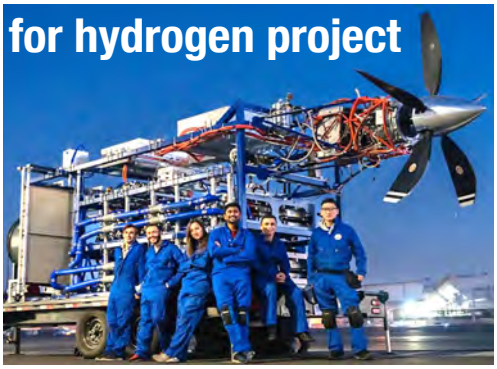
Hartzell pitches in prop for hydrogen project



Hartzell prop mated to a magniX-series electric propulsion system.

De Havilland Dash 8 fuel cell testbed

WHEN UNIVERSAL HYDROGEN'S DE HAVILLAND Dash 8 hydrogen fuel cell-powered testbed first flew in early March, its powertrain included a prop designed and tested for the experimental aircraft by Hartzell Propeller. The 91-inch diameter five-blade swept airfoil carbon fibre propeller featured derivative blades, hub and retention components from an existing certified propeller. The specially designed Hartzell prop is smaller than the standard Dash 8 prop, but provided thrust to keep the aircraft airborne when the other jet fuel powered turbine engine was throttled back during first flight.

"Hartzell Propeller has been around for over a hundred years, and carbon-free flight can power our next century," said Hartzell Propeller president JJ Frigge.

Hartzell also customized a governor for Universal Hydrogen and continues to develop governor advancements for green-powered aircraft. In this first test flight, one of the airplane's turbine engines was replaced with Universal Hydrogen's fuel cell-electric, megawatt-class powertrain. The other aircraft engine was powered by conventional fossil fuel for safety.

Universal Hydrogen's first flight marked the largest hydrogen fuel cell-powered airplane ever to take to the skies and the largest airplane to cruise principally on hydrogen. The airplane flew for 15 minutes, reaching an altitude of 3,500 MSL. The flight was conducted under an FAA Special Airworthiness Certificate and the program is planned to culminate in 2025 with entry into passenger service of ATR 72 regional aircraft converted to run solely on hydrogen. ■

— John Campbell, Editor

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Features

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Upcoming Events

A Family Affair: Abbotsford Airshow 2023

Mark the Days: August 11, 12 & 13

The Abbotsford International Airshow has been a calendar highlight among aviation enthusiasts and families for over 60 years. This year, the Airshow promises to be a memorable experience for all ages. Features include kid-friendly attractions and play areas, interactive exhibits and hands-on learning opportunities for all ages.

Kid-friendly Attractions

One of the most popular areas for families with young children is the Kids Zone. Here, little ones can play on an inflatable adventure playground, crafts and other kids' activities. On top of that, there will be an autograph booth where kids can meet some of the amazing pilots at this year's airshow.

For older children, the Airshow has plenty of options as well. There will be interactive displays, simulators, and also aircraft displays and exhibits where kids can get up close and personal with some of the world's most impressive planes.

Amazing Interactive Exhibits

While the Abbotsford Airshow is a thrilling spectacle of aerial acrobatics, it's also an excellent opportunity for visitors to learn about the aviation industry and the people who make it happen. Several interactive exhibits allow visitors to learn about the science and technology behind aviation.

One of the show's highlights is the S.T.E.M. Zone, which showcases science, technology, engineering, and math in aviation. Visitors can learn about aerodynamics, flight controls, and navigation systems through hands-on activities and demonstrations.

Everyone is invited

At the Abbotsford Airshow, organizers recognize the importance of creating a welcoming and inclusive event for visitors of all ages and backgrounds. The Airshow is committed to making the event accessible to everyone. Show organizers would like to thank the active and retired military for their service by offering complimentary general admission tickets. Discounted tickets are available for additional tickets to family members and friends of military personnel. Children under five receive complimentary admission. ✪

www.abbotsfordairshow.com

RCAF Hornet Demo schedule

July 22	Boundary Bay Airshow	Delta, BC (Tactical)
July 29-30	Red Deer Airshow	Red Deer, Alberta (Tactical)
August 5-6	Alberta International Airshow	Edmonton, Alberta (Aerobatic)
August 11-13	Abbotsford International Airshow	Abbotsford, BC (Aerobatic)
August 26-27	Air Show Atlantic	Debert, Nova Scotia (Aerobatic)
September 2-4	Canadian International Air Show	Toronto, Ontario (Aerobatic)
September 8-10	Festival Aérien Airshow	Mirabel, Quebec (Aerobatic)
September 16-17	Aero Gatineau-Ottawa	Gatineau, Quebec (Tactical)

COMING EVENTS

Paris Air Show 2023 - Ontario Delegation
June 19-23, 2023
Paris, France
www.theoac.ca

Canadian Business Aviation Association Convention
July 11-13, 2023
Calgary, Alberta
www.cbaa-acaa.ca

Boundary Bay Airshow 2023
July 22, 2023
Delta, British Columbia
www.czbb.com

Peace Regional Airshow
July 22-23, 2023
Peace River, Alberta
www.peaceregionalairshow.com

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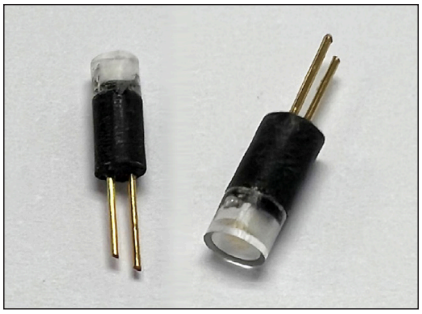


Amglo, a manufacturer of aircraft lighting parts, is offering interior LED aircraft lighting that provides an average life of 50,000 hours, reducing airline maintenance costs significantly due to fewer lamp change-outs. Amglo's LED3071BP replaces the incandescent 3071BP for cabin seat belt/no smoking signs. It has a built-in current limiting resistor and produces warm white SMD LED. FAA/PMA approval is pending. **www.amglo.com**

Ceramic coating reduces drag

Fusion Plus Aircraft is a ceramic coating specifically designed for aircraft. It creates a glossy shell that provides protection against a wide range of environmental hazards, including acid rain, bird droppings and other contaminants. It's Boeing spec-approved and is designed to reduce drag and minimize ongoing care, maintenance time and expenses. Fusion Plus ceramic coating bonds at the molecular level to seal and protect surfaces from environmental contaminants, harmful UV rays and insect acids. It also provides resistance to light scratches and fading. **www.xpel.com**

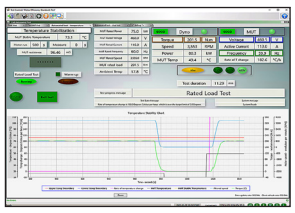
Five-blade prop is Kodiak option

Under a recently approved STC, **Hartzell Propeller's** five-blade composite propeller for Daher Kodiak 100 aircraft will be available as a factory option and for retrofit under Hartzell's Top Prop program. The propeller can replace the four-blade aluminum Hartzell prop, now standard equipment on Kodiak 100s. The design of the new propeller's carbon fibre blades allow RPM to be reduced from 2,200 to 2,000, reducing noise while producing smoother operations with no loss in climb and cruise performance. The new 96-inch diameter prop saves 13 pounds of rotating weight. **www.hartzellaviation.com**

Screwdrivers carry lifetime warranty

Each screwdriver in **Mayhew Tools'** eight-piece slotted and Phillips screwdriver set is made in the United States and features an ergonomic acetate tri-lobular handle delivering maximum strength and torque transfer. Each tip is precision CNC machined to industry specifications with tight tolerances providing reliable fastener engagement. Tempered high alloy steel blades with black oxide finish help to prevent rust. Lifetime warranty included. Founded in 1856, Mayhew Tools is an ISO 9001-certified company and the oldest punch and chisel manufacturer in the United States. **www.mayhew.com**

Tester operates multiple devices



SAKOR Technologies' new DynoLAB GenV test automation controller allows even a non-programmer to implement complex test systems and testing standards. It is built on the latest Windows technologies and development tools in full compliance with current information technology standards. It can be used with a wide array of hardware, including power analyzers, resistance meters, high potential testers, ECUs, video control units, and emissions analyzers. The fully networked test automation controller can operate several different devices independently, so users can perform multiple tests simultaneously, often with a single DynoLAB GenV controller. **www.sakor.com**

Tool chest is light and durable

Gray Tools is now selling industrial-quality mobile tool chests with drawers designed to fit the needs of aircraft maintenance professionals. Constructed of injection-molded copolymer polypropylene, the mobile tool chest is durable and lightweight. It is also shock- and water-resistant. Two side handles, a telescoping rear handle and self-oiling wheels make the unit portable around the shop. A pivoting wheel set can be added for even greater mobility. The tool chest features a removable top tray, lid and front cover. A central lock secures the main compartment with multiple other padlock points included. **www.shopdynamictools.com**

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AIR CHARTER SERVICES WILL BOOM BY 2033

According to a report from industry researcher Fact.MR, the global air charter services market is expected to be valued at US$ 31.9 billion in 2023 and projects the market will rise to enjoy a total valuation of US$ 54.0 billion in 2033. The report cites the globalization of businesses as a major factor with people now buying/selling products digitally and shipping them globally at a record pace. This has resulted in an increased demand for cargo charter services worldwide.

Also, technology and digitalization have made it easy to book charter planes and schedule routes and flight times.

WESTJET LAUNCHES DEDICATED CARGO GROUP

WestJet Cargo and the GTA Group inaugurated the first of three 737-800 Boeing Converted Freighters in Toronto, April 20, signifying the launch of WestJet Cargo and the GTA Group's dedicated freighter service that will cater to businesses, freight forwarders, shippers and individual customers across North America. The freighters will now begin operating between designated hubs in Halifax, Calgary, Los Angeles, Miami, Toronto and Vancouver. They will work in tandem with the cargo carrying bellies of WestJet's fleet, creating global connectivity and opening trade lanes between Canada and the Caribbean, Europe, Japan and the U.S.

LASER MAN GETS TWO YEARS FOR BEING STUPID

The Associated Press reported that a federal judge in Wisconsin sentenced a Minnesota man during the month of April to two years in prison for aiming a laser at a Delta Air Lines jet in 2021. James Link, 43, of Rochester, Minnesota, pleaded guilty in January. According to the U.S. attorney's office in Madison, the pilots of the Delta flight from Raleigh-Durham, North Carolina, to Minneapolis on Oct. 29, 2021, reported that their cockpit was lit up three times by a bright blue laser while they were at an altitude of 9,000 feet (2,700 metres) just west of River Falls, Wisconsin.

FAA WORRIED ABOUT LEAKS IN SYSTEM

Regulators are worried that faucet leaks in Boeing 787 jets could pose a safety hazard by water seeping into the planes' electronics during flights. The Federal Aviation Administration has proposed inspections and, if leaks are found, replacing faucet parts. The move comes after reports of water from lavatories getting under the cabin floor and into electronic equipment bays. The FAA said the leaks could lead to a "loss of continued safe flight and landing." Boeing advised airlines in November about the issue, which has been traced to an O-ring seal and described as a slow leak—about eight ounces of water per hour.

AIRBUS TROTS OUT FIRST US-BUILT H125S

Airbus Helicopters has introduced the first U.S.-built H125 military configurations, known as AH-125 and MH-125 Ares, to the company's range of military helicopters. The AH-125 Ares will be configured as the armed variant of the helicopter, while the MH-125 Ares will be configured as a multi-role helicopter capable of a wide range of operations. The new aircraft complement the line of military helicopters already produced by Airbus, including the H125M. Globally, the H125 family accounts for almost 80 percent of the single-engine market and has the highest number of certified modifications (supplemental type certificates) available.

AIRBUS, P&WC AND PARTNERS WILL RESEARCH SAF

Airbus Canada, Pratt & Whitney Canada, and SAF+ Consortium announced in April a new initiative to collaborate on next-generation sustainable aviation fuel, supported by the Government of Quebec. Known as CADAQ-100, the project will contribute to the industry-wide effort to achieve net-zero CO2 emissions for aviation by 2050. Key areas of collaboration include SAF research and testing, including flight testing blends of up to 100 percent SAF on an Airbus A220 aircraft powered by Pratt & Whitney GTF engines. Typical feedstocks to make SAF include used cooking oil, animal waste fat, solid waste from homes and businesses, and forestry waste.

GO-AHEAD GIVEN FOR SMART LINK INSTALL

Bombardier has unveiled what the company calls "major advancements" in its Smart Link Plus connected aircraft system with several key regulatory approvals, including those from Transport Canada, EASA and FAA for almost its entire fleet of Challenger and Global aircraft. With these approvals, operators will be able to install the Smart Link Plus aircraft health management system which collects crucial aircraft data, enabling flight and maintenance crews to quickly prioritize and proactively troubleshoot essential in-flight alerts, increasing an aircraft's operational efficiency. Aircraft operators can effectively track, troubleshoot and dispatch a technician based on information received from the system.

G400 EXPERIENCE HITS THE ROAD THIS SUMMER

Gulfstream customers across the U.S. will soon get an exclusive look at lavish new interior designs during the G400 Experience Tour, which will include stops in Miami, Houston, Dallas, Denver, Seattle, Chicago, New York, Pittsburgh, and Washington, D.C., during this spring and summer. Three floorplans specify seating for up to 9, 11 or 12 passengers. The G400 also provides the Gulfstream Cabin Experience, with 100 percent fresh air, low cabin altitude, whisper-quiet noise levels and natural light from 10 oval windows, along with a plasma ionization air purification system. ■

Cold Weather Test

This winter, Airbus chose the Canadian north as a venue to continue the latest round of quality control activities in the run-up towards Type Certification of its A321XLR.

IT **WAS AT THE 2019 PARIS AIR SHOW WHEN** Airbus first launched the Xtra Long Range version of its A321neo with a total of 31 initial orders from Air Lease Corporation and Middle East Airlines. Its mission was to offer the longest-range capability of any single-aisle aircraft, covering distances of up to 4,700 nautical miles. With this added range, airlines would be able to operate a lower-cost single-aisle aircraft on longer and less heavily travelled routes – many of which could previously only be served by larger and less efficient wide-body aircraft. This would enable operators to open new world-wide routes such as India to Europe or China to Australia, as well as further extending Airbus's own A321neo family non-stop reach on direct trans-atlantic flights between continental Europe and the Americas.

Since the 2019 Paris Air show the A321XLR program has seen a full agenda of exhaustive testing and quality control activities in the run-up towards Type Certification. Among that suite of activities was a four-day cold-weather ground test at Iqaluit in the territory of Nunavut, during the month of March this winter, and it involved the A321XLR development flight-test aircraft ("FT3,"MSN11080). There are actually four flight test aircraft in the A321XLR development program,

and just a few weeks earlier one of the other A321XLR test aircraft ("FT2", MSN11058) made a similar visit to Iqaluit. On that initial occasion the mission was to test the operation of the hydraulics and other systems at extreme cold temperatures – after an overnight soak at minus 40 degrees Centigrade.

GROUND TESTING THE WATER AND WASTE SYSTEM

"The objective of this most recent cold-weather campaign was to validate the aircraft operation in cold weather for ground operations," says Tuan Do, Lead Flight Test Engineer. "This time around we tested the cabin water and waste system – which required the temperatures inside the unheated cabin to 'soak' at below -15C overnight. To this end, several cold soaks and subsequent ground service operations were conducted over successive days. In each case different heating and insulation configurations were applied for subsequent comparative analysis by the engineering department."

As part of this, a new 'cold weather option' available for A321XLR operators, was tested in real conditions for the first time, which adds insulation and heaters. The tests also validated the 'standard aircraft' configuration – i.e. without the optional package activated.

Of course, every airliner cruises at high altitudes where the outside temperatures are much lower. However, inside the cabin the water and waste systems operate in above zero

temperatures. This is why ground testing (in a completely powered-down state) is specifically called for – so that the ambient environment inside the cabin and below the passenger deck, where many systems are located, can cold-soak at sub-zero temperatures. Following this, in the morning the built-in defrosting/heating equipment was demonstrated, to allow ground servicing to proceed.

HYDRAULICS, OIL AND ELECTRICAL SYSTEM TESTING AT -40C

"During our first five-day visit to Iqaluit a month ago, when we powered-up the aircraft in the morning, we would 'wake-up' the hydraulics, electrics, and other systems and see how long it took to operate the aircraft and get it ready for taxiing and takeoff," says Tuan Do.

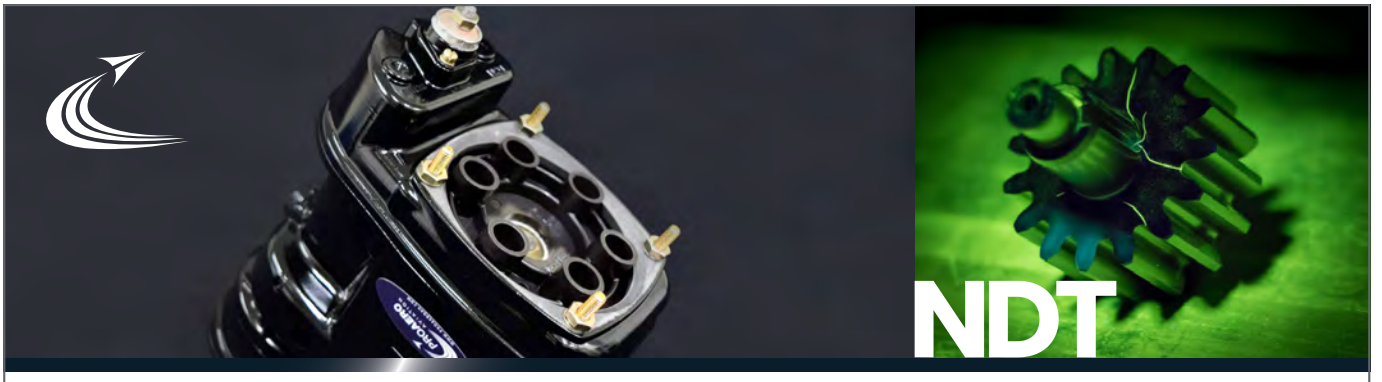
There were also some flights to validate the landing gear operation in very cold temperatures. Notably, the A321XLR features an uprated landing gear – to support the higher maximum take-off weight of the aircraft (whose MTOW is 101 metric tonnes, vs 97 tonnes for the A321LR). Consequently, the shock-absorbers on this new variant are designed to handle higher loads compared with those on the other A320 Family members. The test objective was to check the 'weight-on-wheels' signal, so the aircraft knows when the main landing gear shock absorbers are compressed or extended.

"There are many systems on the aircraft which depend on the weight on wheels signals to tell them whether the aircraft is in flight or on ground," says Tuan Do. "So during our first visit to Iqaluit we verified how the weight-on-wheels function is affected by the physical changes in the main landing gear, and how shock absorber stiffness is affected by cold temperatures."

Another design feature of the -XLR related to hydraulics which needed to be evaluated in the cold environment were new hydraulic lines which pass through Rear Centre Tank, located aft of the Landing Gear bay. "Our design office colleagues wanted us to check that the routing of the pipes did not significantly affect the hydraulic temperatures and operations after warm-up of the aircraft," notes Tuan.

Other cold weather challenges, applicable for any aircraft, include ensuring that hatches don't freeze shut, or that the systems in general don't freeze up – not only the water pipes, oil and hydraulics systems, but also the electrical system, especially batteries.

"Batteries don't hold as much charge or provide as much power output when they are at low temperatures," explains Tuan. "Meanwhile, oil and hydraulics become very viscous at very low temperatures which makes it hard to move flight control surfaces around and drive pumps etc. So you need to heat the aircraft up and its pipework to be able to operate the aircraft."



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HUMAN CHALLENGES

The challenges behind the cold weather campaign also included human ones. There were maintenance and ground support teams who needed to prepare and configure the aircraft, and check everything outside. To that end they needed to have the right clothes and equipment compatible with operations outside. But even with those provisions, the wind-chill factor is so strong in Iqaluit that it's difficult. "You can only work for a limited time outside, so we have shifts to ensure that nobody stays outside for too long," says Tuan.

On-site Airbus for its part, had brought a team of more than 30 people. These included: six flight crew – pilots, flight test engineers, and a test-flight engineer; a cabin specialist engineer; a maintenance team – comprising mechanical specialists, electrical specialists, quality inspectors; instrumentation specialists; systems design specialists; technical photographers; as well as an operations colleague to oversee the logistics for the overall journey.

The human challenges were not simply on-site in Iqaluit, Rather, they begin much earlier. The flight-test engineers needed to agree on the test requirements with the design engineers' office several months in advance, and from that would have prepared the campaign mission plan together with the mission flight-crew and 'test-flight' engineer colleagues. Together they determined how they needed to configure the aircraft inside and out, when to start taxiing and then take-off, and what the ambient and systems temperature conditions should be etc. They would sequence all the testing and planning of the campaign, and of course, ensure that the whole mission was conducted safely.

The A321XLR has been designed to maximize overall commonality with the A321LR and the rest of the A320neo Family, while introducing minimal changes needed to give the aircraft an Xtra Long Range with increased revenue payload. The changes include: the new permanent Rear Centre Tank for more fuel volume; a modified landing gear for an increased maximum take-off weight of 101 metric tonnes; and an optimized wing trailing-edge flap configuration to preserve the same take-off performance and engine thrust requirements as today's A321neo.

In particular, the new optimized RCT holds more fuel than several optional Additional Centre Tanks (ACTs) did previously, while taking up less space in the cargo hold – thus freeing-up underfloor volume for additional cargo and baggage on long range routes. ■

(With Airbus files)

The Future is Now

Alaska Airlines and De Havilland Canada have partnered with high-tech firm ZeroAvia in the development of hydrogen-electric-powered regional turboprops

WHEN ALASKA AIRLINES' regional carrier Horizon Air retired its Q400 (Dash 8-400) fleet, it reserved one of the aircraft for research and development purposes to further advance zero emissions technology for the aviation industry. During a ceremony on May 1, Alaska Airlines presented one of those retired Bombardier regional turboprops to ZeroAvia, a firm that specializes in zero-emission aviation.

At the event held at ZeroAvia's Paine Field research and development site in Everett, Washington, the companies were joined by high school students from Raisbeck Aviation High School, Washington State Governor Jay Inslee, Congresswoman Suzan DelBene and Snohomish County Executive Dave Somers to participate in the formal handover of the 76-seat Dash 8-400, which was repainted with a special livery to highlight the innovative mission of this partnership. The aircraft will now be retrofitted with a hydrogen-electric propulsion system developed by ZeroAvia in an effort to expand the reach and applicability of zero emissions flight technology.

Left: Alaska Airlines has donated a Q400 to ZeroAvia for development of hydrogen propulsion technology.

Above: De Havilland of Canada is the original manufacturer of the Dash 8 family of aircraft.

Right: DeHavilland and ZeroAvia signed a Memorandum of Understanding on December 14, 2021.

Based in the US and the UK, ZeroAvia's focus on hydrogen-electric aviation initially targeted a 300-mile range in nine to 19 seat aircraft by 2025, and up to a 700-mile range in 40 to 80 seat aircraft by 2027. ZeroAvia has already secured experimental certificates for its three prototype aircraft from the Civil Aviation Authority (CAA) and Federal Aviation Authority (FAA), passed significant flight test milestones, secured a number of key partnerships with major aircraft OEMs, landed $10 billion in pre-orders from a number of the major global airlines, and is on track for commercial operations in 2025. The company's UK operations are supported by grants from UK's Aerospace Technology Institute and Innovate UK, and ZeroAvia is part of the UK Government's Jet Zero Council.

In 2021, Alaska Airlines launched a partnership and invested in ZeroAvia to support the development of zero emissions propulsion technology for regional aircraft. As the fifth largest U.S. airline with a large regional network, Alaska has a unique opportunity to support the development of zero-emissions propulsion technology for that sector. By establishing the viability of regional-sized aircraft, both companies will help advance zero-emissions technology across the industry.

ZeroAvia also debuted its breakthrough multi-megawatt modular electric motor system in a 1.8MW prototype configuration at the event – demonstrated with a propeller spin aboard the company's 15-ton HyperTruck ground-test rig. Combined with higher temperature Polymer electrolyte membrane (PEM) fuel cells and advanced power electronics, this electric motor technology is one of three key building blocks for enabling commercially-relevant hydrogen fuel cell engines for larger aircraft.

During the course of this winter, ZeroAvia tested its 1.8MW electric propulsion system configuration at its Hollister location in California with the stock Dash 8-400 engine gearbox and propeller. This configuration consists of two "HyperCore" motor modules, each a high-power, high-speed 900kW permanent magnet radial flux machine which oper-

Above: ZeroAvia has already secured experimental certificates for its three prototype aircraft from the Civil Aviation Authority and Federal Aviation Authority.

ate at 20,000 rpm, matching the typical turbine engine speeds, and providing an unprecedented 15kW/kg motor power density. Crucially, HyperCore's modular design enables the technology to address applications ranging from 900kW up to 5.4MW, meeting a number of regional turbo-prop and regional jet requirements.

The development and testing program will enable the understanding and measurement of system dynamics, calibration of physical and electrical models, and validation of thermal management systems. The company is concurrently developing world-class silicone-carbide power electronics and the matching hydrogen fuel cell systems, which convert hydrogen to electricity, powering the electric propulsion system. These systems will be brought together to create the full hydrogen-electric propulsion system, tested on the ground and then in the air.

Aligning ZeroAvia's powertrain with the Dash 8-400 airframe will represent a commercially viable zero-emission aircraft with fuel cell engine technology around five times more powerful than what has been demonstrated anywhere to date.

"This is a great step forward in aviation innovation, to help create a new future of flight – right here at home," said Alaska Airlines CEO Ben Minicucci. "Alaska Airlines has defined a five-part journey to achieve net zero carbon emissions long-term, but we can't get there alone. New technologies are required to make that future possible, and we're thrilled to partner with industry leader ZeroAvia to make new zero emissions options a reality."

ZeroAvia's recent advancements clear the way for a potential flight of the Dash 8-400, but also demonstrate rapid progress toward certification of the ZA2000 propulsion system.

"Demonstrating this size of aircraft in flight, powered entirely by novel propulsion, would have been unthinkable a few years ago," said CEO and founder of ZeroAvia Val Miftakhov. "Launching this program puts us on track for a test flight next year, and accelerates our progress toward the future of zero-emission flight for Alaska Airlines and for the world at large."

ZeroAvia has already demonstrated a track-record of world-first flight testing. In January, the company took to the skies for the maiden flight of its 19-seat Dornier 228 testbed aircraft, retrofitted with a full-size prototype hydrogen-electric powertrain on the left wing of the aircraft. This was the largest aircraft in the world to be powered by a hydrogen-electric engine.

The flight took place from the company's R&D facility at Cotswold Airport in Gloucestershire, UK, and lasted 10 minutes. At 13.35 pm GMT on the afternoon of January 19, the aircraft completed taxi, take-off, a full pattern circuit, and landing. The landmark flight forms part of the HyFlyer II project, a major R&D program backed by the UK Government's flagship ATI Program, which targets development of a 600kW powertrain to support nine- to 19-seat aircraft worldwide with zero-emission flight.

The twin-engine aircraft was retrofitted to incorporate ZeroAvia's hydrogen-electric engine on its left wing, which then operated alongside a single Honeywell TPE-331 stock engine on the right. In this testing configuration, the hydrogen-electric powertrain comprises two fuel cell stacks, with lithium-ion battery packs providing peak power support during take-off and adding additional redundancy for safe testing. In

Above: This 76-seat Dash 8-400 was repainted with a special livery to highlight its innovative mission.

this testbed configuration, hydrogen tanks and fuel cell power generation systems were housed inside the cabin. In a commercial configuration, external storage would be used and the seats restored. All systems performed as expected.

This was the largest ZeroAvia engine tested to date, and placed the company on the direct path to a certifiable configuration to be finalized and submitted for certification in 2023, with this program also serving as key to unlocking speedy technology development for larger aircraft. ZeroAvia's 2-5 MW powertrain program, already underway, will scale the clean engine technology for up to 90-seat aircraft, with further expansion into narrowbody aircraft demonstrators over the next decade

Of note, this flight test campaign was conducted under a full Part 21 flight permit with the UK CAA, which is a much more stringent set of requirements compared to the E-Conditions framework ZeroAvia used for its six-seat prototype test flights in the prior years. This signifies the maturity of the company's processes and design approaches and its readiness to proceed towards full commercial certification of its powerplants.

ZeroAvia will now work towards its certifiable configuration in order to deliver commercial routes using the technology by 2025. The Dornier 228 will conduct a series of test flights from Kemble, Gloucestershire, England and later demonstration flights from other airports.

This latest achievement follows ZeroAvia's previous world-first milestones, starting with six-seat prototype flights of a Piper M-Class airframe in 2019, and the world's first commercial-scale six-seater hydrogen-electric powered flight in September 2020. The 2020 prototype was a part of the HyFlyer I program in the UK. Unlike the previous tech demonstrator program, ZeroAvia's 600kW engine being developed under HyFlyer II is a commercial-intent program.

The hydrogen-electric powertrain on board was fuelled using compressed gaseous hydrogen produced with an on-site electrolyzer. To enable hydrogen production on site, ZeroAvia and HyFlyer II partner the European Marine Energy Centre (EMEC) have delivered and operated the Hydrogen Airport Refuelling Ecosystem (HARE), a microcosm of what infrastructure will look like in terms of green hydrogen production, storage, refueling and fuel cell powered flight. The system's electrolyzer capacity was doubled earlier this year from its initial design for the latest project.

ZeroAvia's HyFlyer II program to develop its ZA-600 hydrogen-electric engine and retrofit the Dornier 228 is being delivered in partnership with EMEC and Aeristech and is supported by the UK Government through the ATI Programme and the Department for Business, Energy Industrial Strategy, Innovate UK and Aerospace Technology Institute. ZeroAvia's Val Miftakhov is also a member of the UK Government's Jet Zero Council.

January's historic first flight follows significant commercial momentum for ZeroAvia in recent months, including an engine order from American Airlines, a partnership agreement with OEM Textron Aviation and infrastructure partnerships with airports including Rotterdam, Edmonton International and AGS Airports. With 1,500 engines on pre-order, partnerships with seven aircraft manufacturers, and a number of fuel and airport partnerships,

ZeroAvia's hydrogen-electric engine uses fuel cells to generate electricity from hydrogen fuel, before using that electricity to power electric motors that turn the aircraft propellers. The certifiable ZA2000 system will include ZeroAvia's High Temperature PEM fuel cells and liquid hydrogen fuel storage, integral to delivering the necessary energy density for commercial operations of large regional turboprops. The company has already established an engineering partnership with De Havilland of Canada, the original manufacturer of the Dash 8 family of aircraft, to enable exchange of data and expertise with the airframe.

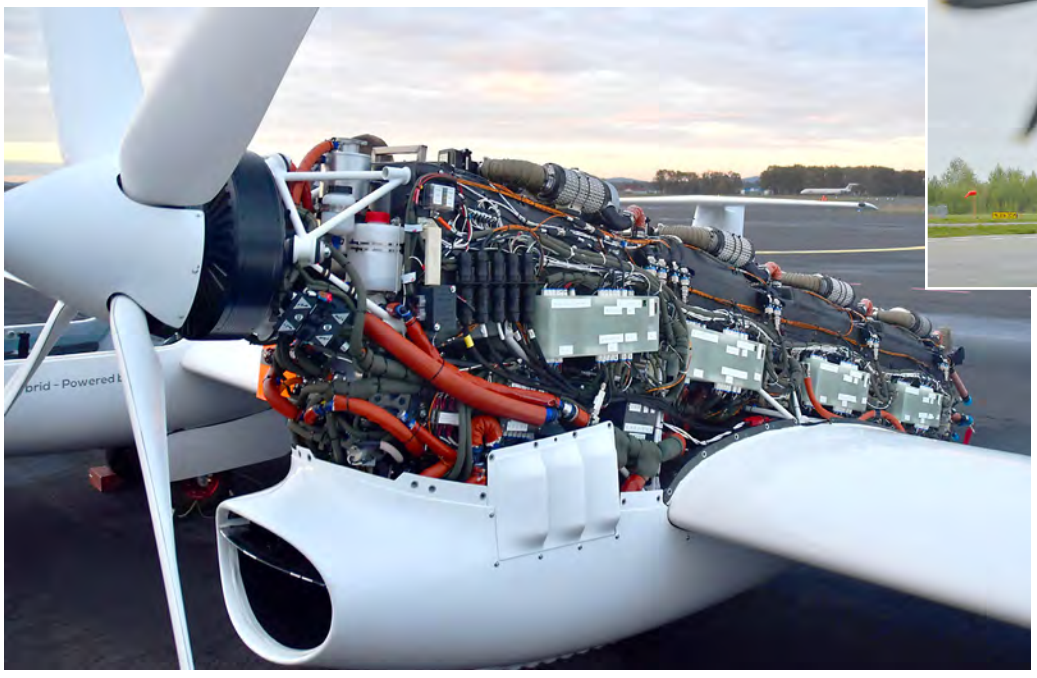
The two companies signed a Memorandum of Understanding (MOU) on December 14, 2021 while announcing they have entered the MOU to develop a line-fit and retrofit program for De Havilland Canada's aircraft models, using hydrogen-electric propulsion in both new and in-service aircraft.

As part of the MOU, De Havilland Canada will be issued options to purchase 50 ZeroAvia hydrogen-electric engines. These options will be confirmed once a definitive agreement has been completed between De Havilland Canada and ZeroAvia.

"De Havilland Canada have made significant strides on emission reductions and shown a big commitment to greener aviation," said Miftakhov. "And the next step is to go to true zero-emission using hydrogen-electric engines. Partnering with De Havilland Canada puts ZeroAvia on a defined pathway to line-fitting into new airframes and signals OEM appetite to make the switch to certified, zero-emission propulsion as soon as possible."

The companies intend to work together on a service bulletin for the Dash 8-400 type certificate offering ZeroAvia's hydrogen-electric engine as a line-fit option for new aircraft, as well as developing an OEM-approved retrofit program for

In January, ZeroAvia took to the skies for the maiden flight of its 19-seat Dornier 228 testbed aircraft.



Above: ZeroAvia's HyperTruck gives you a sense of the propeller's scale.

Left: The tight complexity of ZeroAvia's HY4-65kw-system is open for inspection.

in-service aircraft. This program will target the use of ZeroAvia's 2MW+ powertrain (ZA2000) for Dash 8-400 aircraft. The Dash 8-400 is one of the world's most reliable turboprop aircraft with more than 625 delivered to customers. The global fleet of Dash 8-400 aircraft has logged over 11 million flight hours and transported more than 550 million passengers.

As part of the program, ZeroAvia will develop a flight demonstrator, with De Havilland Canada's support, using a Dash 8-400 aircraft to aid certification and showcase the operational and commercial potential of the engine. The intention is to identify a suitable existing route utilizing the aircraft and aim for entry into service within the next five years. ZeroAvia and De Havilland Canada intend to jointly market aircraft powered by the hydrogen-electric engines to operators with power-by-the-hour (PBH) support.

"De Havilland Canada has a strong belief in hydrogen-electric technology as a viable solution for de-carbonizing aviation," said Dave Riggs, De Havilland Aircraft of Canada's Chief Transformation Officer. "We are extremely pleased to be collaborating with ZeroAvia in developing climate-friendly propulsion as an option for our customers around the globe."

Today, aviation is the fastest-growing source of greenhouse gas emissions. By 2050, its share of climate impact is expected to be 25-50 percent. This is why regulators worldwide are pushing for green aviation and net-zero carbon emissions by 2050. With up to 30 times higher specific energy and lower cycling costs than lithium-ion batteries, and numerous advantages over all other decarbonization solutions, hydrogen-electric powertrains are considered by many to be the only currently obvious way to scale sustainable aviation for commercial use. ■

(With ZeroAvia files.)

ZeroAvia's twin-engine 19-seat Dornier 228 aircraft.

Above: ZeroAvia's hydrogen-electric powertrain development program aims to power 40-80 seat aircraft with zero-emission engines by 2026.

PACIFIC

Pacific AME Association

About Us

PAMEA is a non-profit association comprised of aircraft maintenance engineers, aircraft maintenance personnel and aviation industry corporate members. PAMEA is an active member of the Aircraft Maintenance Engineers of Canada (AMEC). Your Association believes strongly in the National Association AMEC/TEAC and our relationship with the national organization going forward primarily in that Transport Canada will only communicate with AMEC/TEAC regarding Aircraft Maintenance Engineers (AME) issues.

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.

This means we'll have more time to concentrate on Conferences, our Monthly Newsletter, and 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 president@wamea.com

Phone: 587-713-WAME (9263)

Website Maintenance

While the WAMEA website is undergoing maintenance, please take the opportunity to peruse the National AME Association website for your professional interests at: **http://www.amec-teac.ca**

Thank you for your patience,

Greg Andersen

President

Western AME Association

www.wamea.com

CENTRAL

Central AME Association

Association Objectives

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

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
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A Busy Spring

On Saturday, April 29, we attended the Girls Take Flight event at CYOO (Oshawa Airport). Carolyne Mounsey, AME, represented the Association with some fun, interactive activities designed to show girls and young women that not only can girls fly...but they can also FIX aircraft, pretty well too!

At the Skills Ontario Competition on Monday, May 1, the AME Association of Ontario proudly arranged and hosted almost 100 elementary school aged visitors to the Aircraft Maintenance Competition site to highlight the 2023 Elementary Career Awareness Workshops. Visitors from several schools, completed hands-on tasks such as creating a cellphone holder out of aircraft sheet metal, by de-burring, assembling and riveting the components together. Special thanks to VMO Aerospace for donating the materials, tooling and expertise to send home some of the young people with a keepsake of their hard work.

Also, present were two of Air Canada's AMEs, who introduced some of the visitors to Air Canada's Airbus A320 Trimable Horizontal Stabilizer Assembly and let some of the Workshop participants try their hand at lock-wiring some of the fasteners on the THSA! Thanks to Air Canada and AMEs Shaun Warboys and Dean Fudge for making the lock wire activity safe, fun and interesting!

The Skills Ontario Competition continued on Tuesday, May 2. Nine Community College ATO students from Confederation College in Thunder Bay, Canadore College in North Bay, Centennial College in Toronto and Mohawk College in Hamilton competed for the honour to represent Ontario at the May 25 & 26 Skills Canada National Competition. Events included a Sheet Metal and Composite project; an Electrical Wiring Interconnect System (EWIS) project; a Lock wire project; a Piston Engine project; and a CARs & Human Factors Knowledge Test.

A very special thank you to Marie McCullough, and Flight Path International who donated a prize of a seat on a Type Endorsement Aircraft Maintenance Course to Connor L. of Canadore College.

The Medallists in this year's competition were:

Bronze - Avienda W. (Confederation College);
Silver - Connor L. (Canadore College);
Gold - Emma C. (Canadore College).

Congratulations to all nine competitors and best of luck to Emma who competed in the Skills Canada National Competition on May 25 & 26 in Winnipeg, Manitoba against the best of the rest of Canada!

On Saturday, May 13 we were at the Waterloo Wellington Airport's Girls Can Fly Event.

Annual Conference and Workshop

The conference committee has rescheduled our annual conference to November. - FYI : **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

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**

We have recently been active at different levels and had the pleasure of participating in the Career Day of the École nationale d'aérotechnique in St-Hubert on March 29 and had the chance to meet many future AMEs there. More than 43 companies that employ AMEs in Quebec were present. Our presence allows students to learn more about their new career and what awaits them during their first job. Also, many new students take advantage of this day to find information. The Quebec AME Association continues to progress on various subjects such as some regulatory questions from our members and the search for new benefits for them with various partners.

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

ATLANTIC

Atlantic AME Association

A message from President, Bob Pardy

Thank you, from your Board of Directors for your continued support of the AME Association (Atlantic) and from all the members of Aircraft Maintenance Engineers of Canada / Techniciennes d'Entretien d'Aéronefs du Canada (AMEC/TEAC) for your support of our national Association.

It's time again to renew your AME Association (Atlantic) membership. I hope you see value in this; our association works with the regulator for the benefit of your AME license and privileges.

We are offering you the opportunity to renewing your membership on line, on our website at https://www.atlanticame.com. There you can find information about the 2023 ARAMC, our newsletters and other information that may be of interest to you.

Your membership includes; membership in (AMEC/TEAC), subscriptions to several magazines and a 10 percent discount card to use at any Mark' Work Warehouse in Canada, all valued at over $170. Training courses are presented as demand dictates and you will enjoy reduced fees for these events. The AME Association (Atlantic), in partnership with AMEC/TEAC aim to be your voice and support to our Industry.

About AME Association (Atlantic)

Atlantic AME Association is one of six similar associations across Canada; the others being the Quebec, Ontario, Central, Western and Pacific associations. These associations represent regional interests, as well as concerns of national importance. The Aircraft Maintenance Engineers of Canada/ Techniciens d'Entretien d'Aéronefs du Canada, is a national body, which is supported and financed by all the regional associations and which represents the associations at the national level.

We strive to maintain and enhance standards and professionalism of AMEs and to protect their rights and privileges. The association works with and consults Transport Canada in the formulation of new rules and regulations to promote the viewpoint of the AME.

A separate committee under the auspices of the association runs an annual Conference. This two-day event features speakers on a variety of topics, and includes a trade show with over thirty-five booths from various suppliers, manufacturers and organizations. Attending various sessions may be counted toward the recurrent training requirements required by Transport Canada, provided that your employer has this conference listed in their approved manual.

www.atlanticame.com

SOCAL

SoCal PAMA Chapter

PAMA Announces Scholarship Recipients

On April 20, PAMA recognized its 2023 scholarship award recipients during the award ceremony at the Aerospace Maintenance Competition in Atlanta. The award recipients are as follows:

Brian Cleveland is currently a 4.0 student at the Aviation Institute of Maintenance in Houston. As an older student, on top of pursuing his A&P license, Brian is a father and an unlicensed mechanic for Mesa Airlines. His letters of recommendation highlight his determination, eagerness to learn, and willingness to lend a helping hand to other students in need. Once he obtains his license, Brian hopes to become proficient in repairing a variety of aircraft and possibly open his own consulting business one day. Brian is the recipient of a $1,500 scholarship, courtesy of JSfirm.com.

Joel Mink is a student at Cincinnati State Technical and Community College. He has already obtained his Private Pilot License and is now in pursuit of his A&P Certification. In addition to being a student, he is currently employed as a ground support equipment maintenance assistant at Trego-Dugan Aviation. Joel's letters of recommendation highlight his work ethic and fervent determination. Joel is the recipient of a $1,500 Glenn McCauley Aviation Technician Award provided by the Ohio Aircraft Technicians Society.

Lei Huot is currently in pursuit of her A&P certification at Embry-Riddle Aeronautical University, inspired by her grandfather who was a mechanic in the United States Air Force. In addition to being a student, Lei has already clocked in over 150 apprenticeship hours with Eagle Aircraft Maintenance. In her letters of recommendation, the owner of Eagle Aircraft Maintenance speaks of her dedication, character, and calls her an asset to their team. Lei is the recipient of a $1,000 scholarship, courtesy of the Jack D. Prewitt Memorial Scholarship, provided by PistonPower™ by AEPC™.

Christopher Drewel is a student at the State Technical College of Missouri. At a young age, Christopher was introduced to aviation after his first flight in a Cessna 172. In addition to pursuing his A&P license, he is also a student pilot at Osage Aviation and an active member in several aviation related organizations. His letters of recommendation call him "impressive" and "always dependable", as well as highlighting his integrity. Christopher is the recipient of a $1,000 scholarship, courtesy of the Jack D. Prewitt Memorial Scholarship, provided by PistonPower by AEPC.

www.socalpama.org

Central Ohio PAMA

Flight Safety Detectives

(Episode 161 - Famed R&B Singer Killed in Air Crash Caused by Safety Errors)

Eight passengers and a pilot were onboard the Cessna 402B charter flight. John and Todd discuss the details of the accident report and the multiple organizational issues of the aircraft operator.

They find that shoddy airline operations are at the center of the cause of this event. They talk about the specific shortcomings that involve everything from pilot verification, to aircraft maintenance to illegal operations.

John and Todd talk about the management oversight and systems needed to safely operate a charter airline. They also cover the responsibility of people booking these flights to check out who they are working with.'s hard to see the forest for the trees and an extra set of eyes is always appreciated.

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

Ice on the Wing

A simple weather-check might have spared this Mooney some grief.

Accident site looking northwest.

AT **1427 ON 22 APRIL 2022,** the Mooney M20K (Mooney 231) aircraft (registration C-GQMS, serial number 25-0536) departed Runway 35 at Calgary/Springbank Airport (CYBW), Alberta, for a local round-robin flight on an instrument flight rules (IFR) flight plan with 2 pilots on board. The aircraft had recently been purchased, and the purpose of this flight was for the right-seat pilot to become familiar with operating the Mooney 231 and learn from the pilot-in-command, who was occupying the left seat and had experience on the aircraft type. The aircraft was later to be relocated to its new owner in Fort St. John, British Columbia, where the right-seat pilot was to provide type-specific instruction to the new owner.

After takeoff, the aircraft turned left toward the TURNY waypoint, climbing to a cruising altitude of 9000 feet above sea level (ASL). It flew over High River Aerodrome (CEN4), Alberta, and headed northeast toward the EBGAL waypoint. The aircraft then turned left and proceeded back toward the TURNY waypoint. When the aircraft was flying just northwest of Okotoks (CFX2), Alberta, at an altitude of approximately 8000 feet ASL, it turned slightly to the right to cross the initial approach waypoint (SEKEM) and return to CYBW for an instrument approach and landing on Runway 35.

At 1509, before crossing SEKEM, the pilot-in-command contacted air traffic services (ATS) and requested a lower altitude because the aircraft was "picking up a little ice." ATS cleared the aircraft to descend, with a restriction of not below 6200 feet ASL.

The aircraft crossed SEKEM at an altitude of 6100 feet ASL, travelling at a ground speed of 97 knots. It then crossed the step-down waypoint (XUBUM) at an altitude of 5900 feet ASL, travelling at a ground speed of 114 knots, and crossed the final approach waypoint (TARTI) at an altitude of 5800 feet ASL, approximately 500 feet above the vertical path angle and still travelling at a ground speed of 114 knots.

The aircraft continued to descend, and passed below the vertical path and ultimately below the decision altitude of 4190 feet ASL. At 1518, it struck the bank of a ditch on the north side of the Trans-Canada Highway, 0.6 nautical miles (NM) south of the threshold of the runway, and slid to

Ice can form on aircraft in flight, mainly as a result of 3 processes.

The accumulation of ice has quite a detrimental effect on the drag of an airfoil.

a halt in a pasture. The pilot-in-command was fatally injured from the impact forces, and the right-seat pilot received serious injuries. The emergency locator transmitter (ELT) activated and transmitted a signal.

AIRCRAFT INFORMATION

The Mooney M20K is a low-wing, single-engine, 4-seat, general aviation aircraft with retractable tricycle landing gear. It is powered by a turbocharged 6-cylinder piston engine. The occurrence aircraft was manufactured in 1981.

The investigation did not identify any issues related to the aircraft's equipment or maintenance that would have prevented it from operating normally during the occurrence flight. The aircraft had been purchased by a new owner in March 2022 and, as part of that process, had gone through extensive maintenance, including an annual inspection.

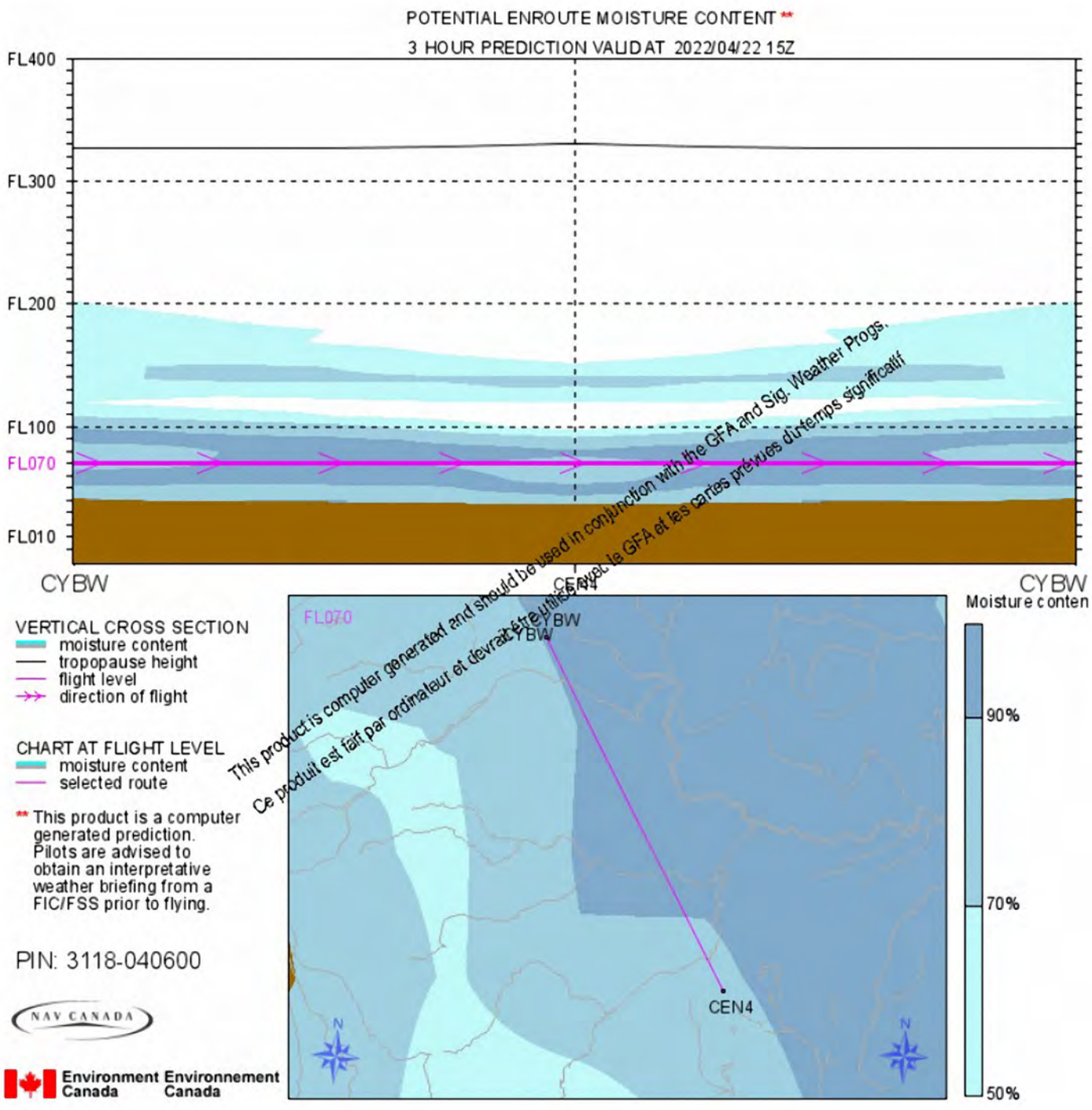
The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was it required to be by regulation. The aircraft was also not equipped, or certified, for flight into known or forecast icing conditions. The Canadian Aviation Regulations stipulate that where icing conditions are reported to exist or are forecast to be encountered, the aircraft must be adequately equipped to operate in icing conditions.

The aircraft was equipped with electric deicing boots on the propeller. It was also equipped with a 406 MHz ELT (Artex ELT 345), which activated. The signal was received by the Joint Rescue Co-ordination Centre (JRCC) in Trenton, Ontario.

IMPACT AND WRECKAGE INFORMATION

The aircraft collided with the bank of a ditch on the north side of the westbound lanes of the Trans-Canada Highway. The aircraft hit the ground in right-wing-low, nose-down attitude, went through a barbed wire fence, and came to rest 68 feet north of the ditch, facing a southerly direction.

During the impact sequence, the right wing broke off the aircraft, the crankshaft propeller flange and propeller broke free, the left main landing gear was torn from the left wing, and the left elevator contacted the field, resulting in significant

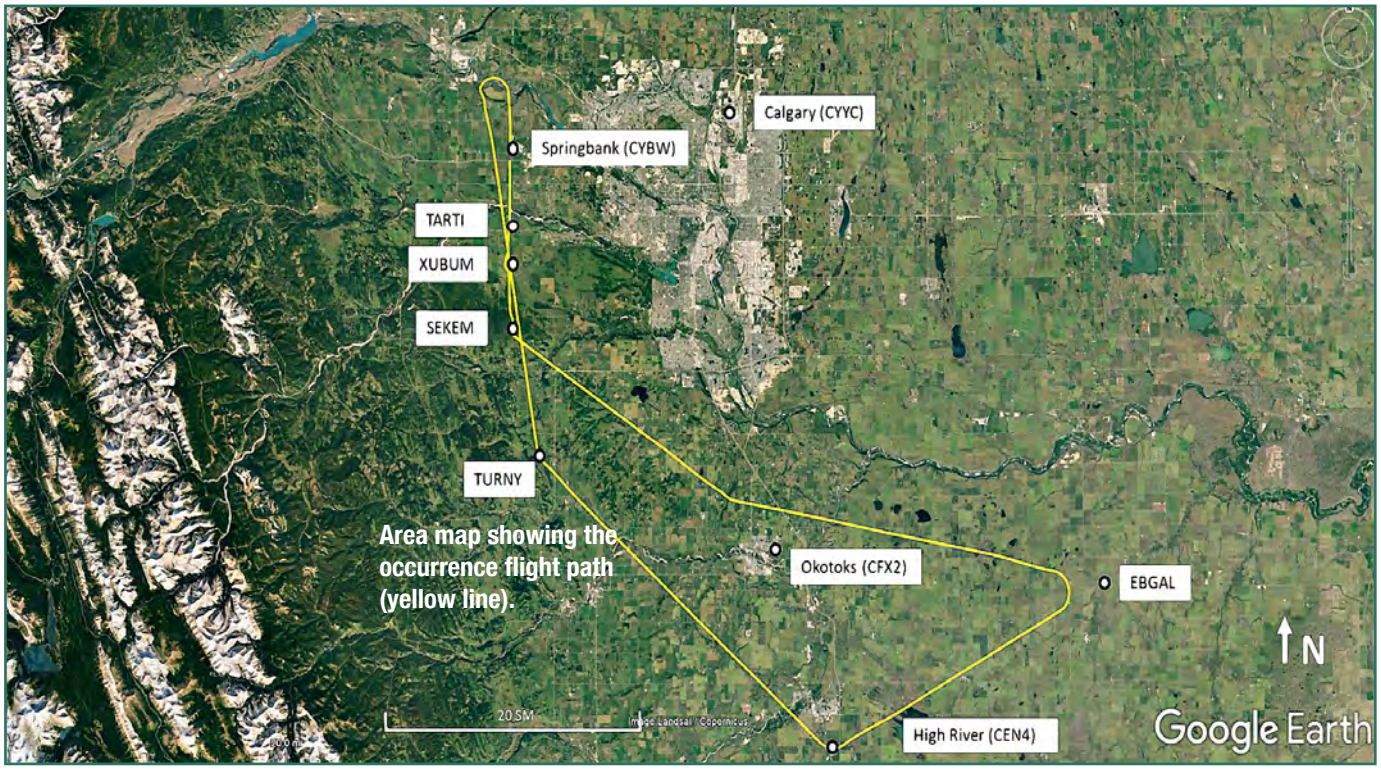


damage and distortion to the aft fuselage. After the aircraft came to rest, the engine continued to run at high speed because there was no longer any propeller load on the engine. Bystanders turned off the ignition to the engine and provided assistance to the aircraft occupants.

RCMP officers from the Cochrane detachment responded shortly after the accident. Several photos were taken of the exterior of the aircraft and shared with the TSB. The photos revealed a build-up of mixed ice on the aft VHF (very high frequency) communication antenna, the leading edges of the horizontal stabilizer, and the leading edge of the left wing. The investigation estimated the build-up of the mixed ice on the VHF communication antenna to be between ¾ and 1 inch thick.

The aircraft's digital tachometer was sent to the TSB Engineering Laboratory in Ottawa, Ontario, for analysis. The data recovered from the unit indicated that the engine was operating normally for the duration of the flight.

The Clouds and Weather Chart of the graphic area forecast (GFA) valid at the time of the occurrence indicated frequent altocumulus castellanus clouds in the vicinity and to the west



Area map showing the occurrence flight path (yellow line).

of CYBW. These clouds continued all the way to the border with British Columbia, with a visibility of 1 to 4 SM in light snow showers, and patchy ceilings between 800 and 1500 feet AGL. A note below the legend on the Clouds and Weather Chart states: "CB TCU AND ACC IMPLY SIG TURB AND ICE" (cumulonimbus, towering cumulus, and altocumulus castellanus imply significant turbulence and icing).

The Icing, Turbulence, and Freezing Level Chart of the GFA did not depict any areas of moderate or severe icing conditions in the vicinity of CYBW; however, it did indicate the freezing level to be at 5000 feet ASL. A note below the legend on the Icing, Turbulence, and Freezing Level Chart states: "NIL-LGT RIME ICEIC ABV FZLVL UNLS NOTED" (nil to light rime icing is to be expected in cloud above the freezing level unless noted).

In addition to the weather information products mentioned above, pilots can consult NAV CANADA's automated supplementary enroute weather predictions (ASEP) page from the Aviation Weather Web Site. Appendix A provides samples of the graphic depictions of the conditions between 0900 and 1200 on the day of the occurrence. These graphics depict the potential for an aircraft to experience in-flight icing in the vicinity of the planned flight route and at the planned altitude.

The investigation was unable to determine with certainty what weather information the pilots consulted before the occurrence flight; however, the pilots had not contacted a NAV CANADA flight information centre for a weather briefing before departure. The Canadian Aviation Regulations require that the pilot-in-command be familiar with the available weather information appropriate for the intended flight.

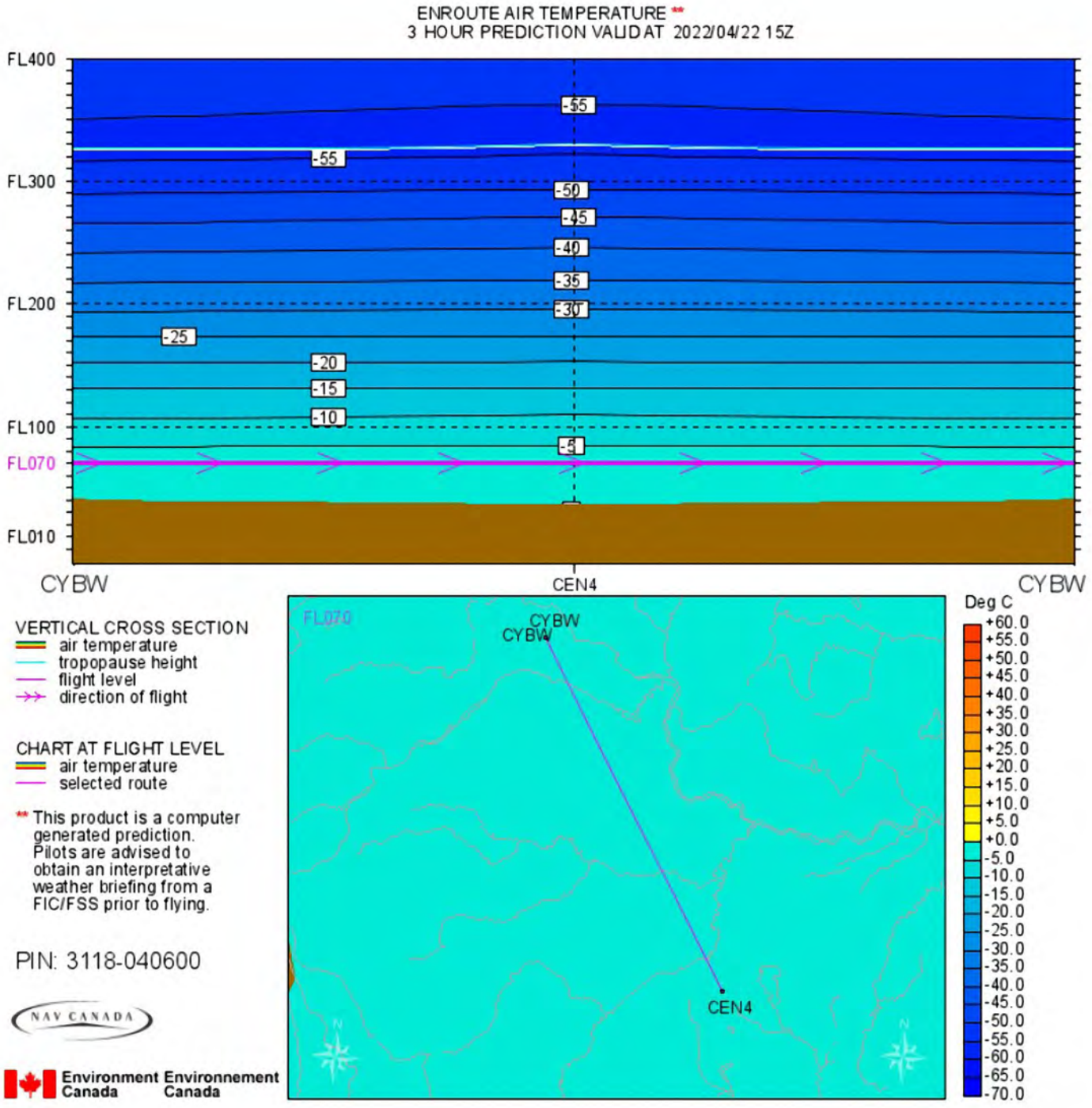
IN-FLIGHT ICING

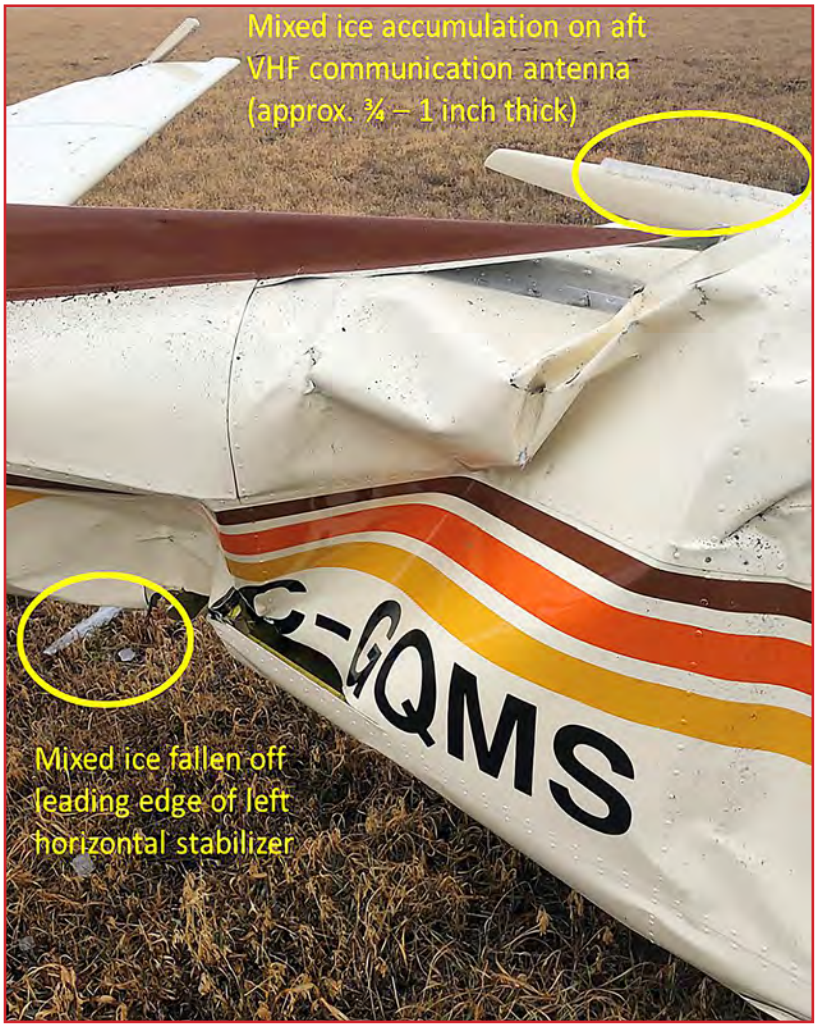
Ice can form on aircraft in flight, mainly as a result of 3 processes: super cooled water droplets, freezing of liquid water, or the transition of vapour directly to ice. Depending on the process involved and the conditions, these accretions are normally classified into 4 categories: clear ice, rime ice, mixed ice, and hoarfrost. All of these types of accretions degrade performance, although to varying degrees, and all aircraft are affected negatively when accumulating ice in flight.

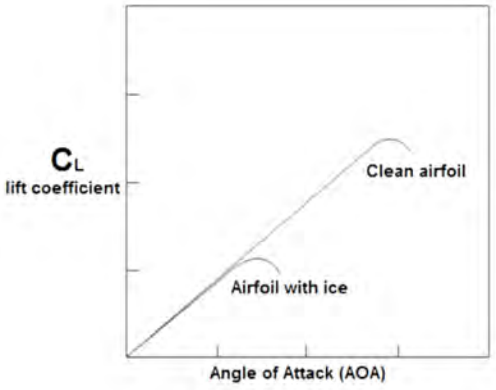
Structural aircraft icing occurs when the various parts of an aircraft (wings, stabilizers, antenna, etc.) accumulate ice during flight. The effects of structural icing on aircraft performance have been well documented. In August 2015, the U.S. Federal Aviation Administration published Advisory Circular (AC) 91-74B: Pilot Guide: Flight in Icing Conditions, which provides "essential information concerning safe flight in icing conditions, what conditions a pilot should avoid, and how to avoid or exit those conditions if encountered."

As described in AC 91-74B, the accumulation of even a small amount of ice on an airfoil in flight significantly reduces the maximum amount of lift available at any given airspeed or angle of attack, and significantly reduces the angle of attack at which a stall occurs. It is not unusual for the maximum coefficient of lift to be reduced by 30%.

The accumulation of ice also has a detrimental effect on the drag of an airfoil. This means that as ice accumulates on the surface of the airfoil, the drag increases significantly and quickly as the angle of attack increases. It is not unusual for drag to increase by 100%.

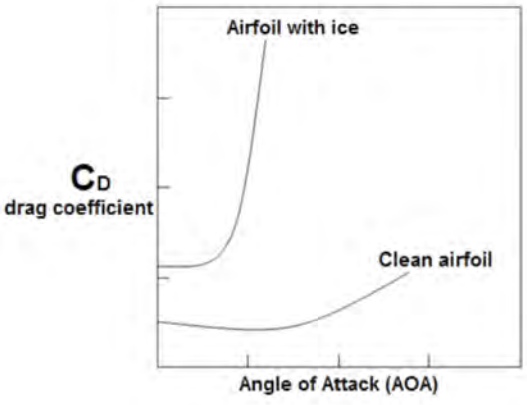

ENROUTE AIR TEMPERATURE **
3 HOUR PREDICTION VALID AT 2022/04/22 15Z
FL400
FL300
FL200
FL100
FL070
FL010
-55
-55
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
CYBW
CEN4
CYBW
VERTICAL CROSS SECTION
air temperature
tropopause height
flight level
direction of flight
CHART AT FLIGHT LEVEL
air temperature
selected route
** This product is a computer generated prediction. Pilots are advised to obtain an interpretative weather briefing from a FIC/FSS prior to flying.
PIN: 3118-040600
NAV CANADA
Environment Canada
Environnement Canada
FL070
CYBW
CYBW
CEN4
Deg C
+60.0
+55.0
+50.0
+45.0
+40.0
+35.0
+30.0
+25.0
+20.0
+15.0
+10.0
+5.0
+0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0





Above: Graph showing how ice affects the coefficient of lift for an airfoil.

Below: Graph showing how ice affects the drag coefficient of an airfoil.



IN ADDITION, AC 91-74B NOTES THE FOLLOWING:

An aircraft with a completely unprotected wing is unlikely to be certificated for flight in icing conditions, but may inadvertently encounter icing conditions. […] The ice causes an increase in drag, which the pilot detects as a loss in airspeed or an increase in the power required to maintain the same airspeed. (The drag increase is also due to ice on other parts of the aircraft). The longer the encounter, the greater the drag increase; even with increased power, it may not be possible to maintain airspeed. If the aircraft has relatively limited power (as is the case with many aircraft with no ice protection), it may soon approach stall speed and a dangerous situation.

SAFETY MESSAGES

Pilots must be diligent when checking the weather before a flight by consulting all available weather resources, including NAV CANADA flight information centres, and reviewing all available weather products, including pilot reports and special weather reports, for the area of the planned flight.

Weather conditions that are conducive to icing are difficult to predict. If icing is encountered when flying aircraft that are not certified for icing conditions, it is imperative that pilots exit the icing conditions immediately. Additionally, pilots should treat this situation as an emergency and declare it as such in order to obtain all available assistance. ■

(These were excerpts from the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 12 October 2022. It was officially released on 17 October 2022.)

By Mark Lacagnina Flight Safety Foundation

Panic Mode

Brake failure can arrive in unexpected ways. Here, the Flight Safety Foundation reports on two very different incidents.

Bombardier Canadair.

Bombardier Canadair Challenger: brakes failed on one wheel

(Substantial damage. One serious injury, one minor injury.)

THE BRAKES HAD FUNCTIONED normally when the flight crew landed the Challenger on a 5,008-ft (1,526-m) runway at Florida Keys (U.S.) Marathon International Airport during a positioning flight the afternoon of March 1, 2015. After boarding six passengers, including the owner of the airplane, the crew departed from Marathon for a corporate flight to Marco Island, Florida, about 80 nm (148 km) northwest. The pilot-in-command (PIC) was the pilot flying.

Visual meteorological conditions prevailed at the destination. The automated weather observation system was reporting surface winds from 250 degrees at 5 kt, 10 mi (16 km) visibility and a few clouds at 9,000 feet.

Nearing Marco Island, the pilots saw an area of rain showers moving toward the airport from the east but observed that the runway appeared to be dry. They requested and received clearance from air traffic control (ATC) to conduct a visual approach to Runway 17, which was 5,000 ft (1,524 m) long.

"Before the approach, the pilots reviewed the speeds and [required] landing distance," said the report by the U.S. National Transportation Safety Board (NTSB). "The calculated required landing distance, assuming a Vref [reference landing speed] of 133 knots, was 3,166 feet [965 m] for a dry runway and 4,166 feet [1,270 m] for a wet runway."

The PIC flew the left downwind leg closer to the runway than normal to avoid the rain showers east of the airport and then made a continuous turn onto final approach. Airspeed was about 5 kt higher than Vref when the Challenger crossed the runway threshold. The report said that the pilot likely did

The Raytheon 390 Premier I (at left) before and (below), after incident.

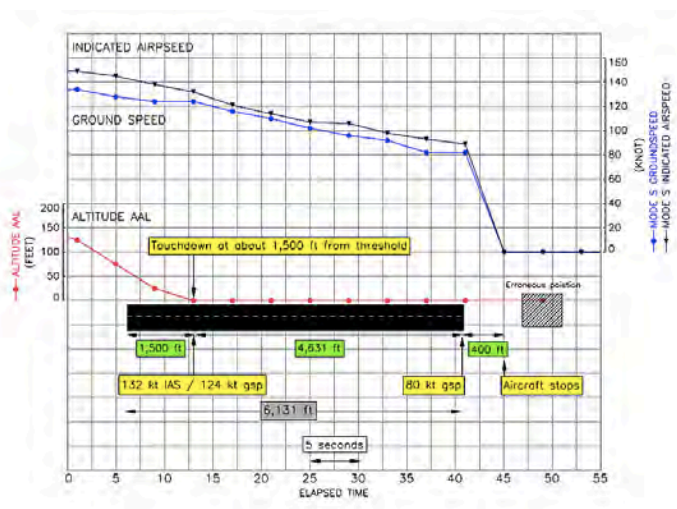


Figure 2
Salient final approach and landing data

not flare the airplane properly, resulting in a touchdown more than 1,000 ft (305 m) beyond the approach threshold.

The crew attempted unsuccessfully to deploy the ground spoilers and thrust reversers after touchdown. The PIC applied manual wheel braking but perceived that the airplane was not decelerating. He released the brakes, disengaged the anti-skid system and reapplied the brakes. "The SIC [second-in-command] reported that he, too, applied the brakes because he felt no deceleration," the report said. The hard manual braking, with no anti-skid protection, caused the tires on the left outboard wheel and both right wheels to burst.

The Challenger overran the runway at about 35 kt and came to stop in sand about 250 ft (76 m) past the departure threshold after the nose landing gear collapsed. The airplane owner had left his seat when he realized that the airplane was not going to stop on the runway; he was moving toward the cabin door when he was thrown against the side of the cabin and sustained serious injuries. Another passenger suffered a minor back injury. The other three passengers, the flight attendant and the two pilots escaped injury.

Examination of the airplane revealed that a spring in an upper brake control valve had failed, causing a loss of braking of the left inboard wheel. In addition, a coupling subassembly had fractured during the landing roll, causing a loss of braking of the left outboard wheel.

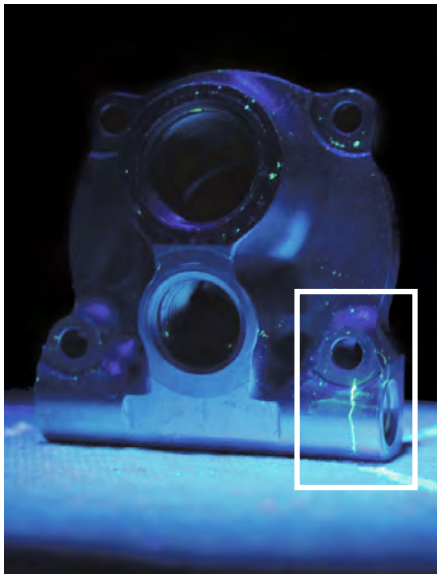
The NTSB concluded that the brake component failures and the "PIC's deactivation of the anti-skid system even though there were no anti-skid failure annunciations" were the probable causes of the accident. Contributing factors were the "PIC's improper landing flare" and his unsuccessful attempts to deploy ground spoilers and thrust reversers, which functioned normally during post-accident tests.

"The PIC's unsuccessful attempts to deploy the ground spoilers and thrust reversers were likely due to errors made while multi-tasking when presented with an unexpected situation (inadequate deceleration) with little runway remaining," the report said.

Raytheon 390 Premier I: fatigue crack in left hydraulic pump

(Destroyed. No injuries.)

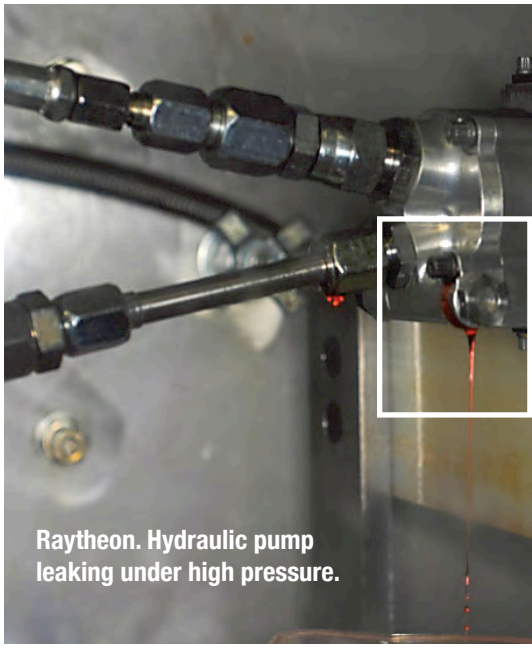
While descending through 12,000 ft to land at Blackpool (England) Airport the morning of March 12, 2015, the flight



Raytheon. Crack in the port cap shown with dye penetrant under UV light.

crew observed cautionary annunciations of low hydraulic pressure. The hydraulic pressure gauge showed fluctuations but indicated that pressure was 2,800 psi (within the green arc) most of the time, said the report by the U.K. Air Accidents Investigation Branch (AAIB). The low-pressure annunciations illuminated intermittently.

"The copilot then actioned the 'Hydraulic Pump Failure' checklist," the report said. "It stated that if the hydraulic pressure was a minimum of 2,800 psi, the flight could be continued."



Raytheon. Hydraulic pump leaking under high pressure.

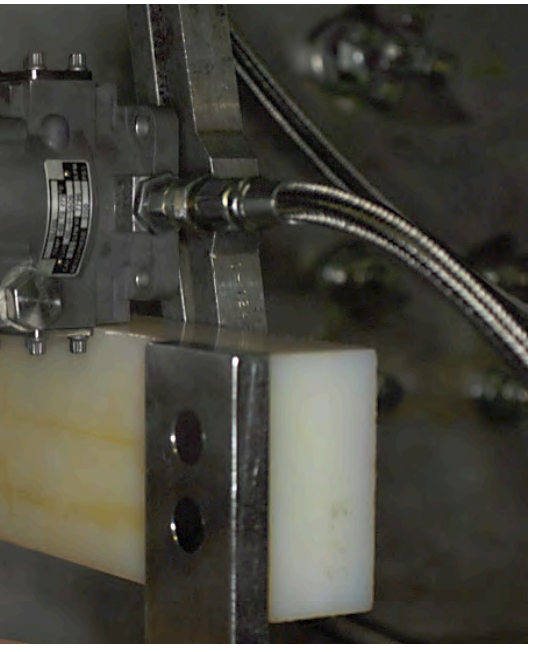
As the crew began the initial approach to Runway 10, which was 6,131 ft (1,869 m) long, they received cautionary messages that the hydraulic speed brake system, the roll spoiler system and the wheel-braking system had failed. The copilot consulted the associated checklists, which advised in part that, with these systems not functioning, the required landing distance was 4,950 ft (1,509 m), compared with the normal landing distance of 3,000 ft (914 m). The pilots decided to continue the approach.

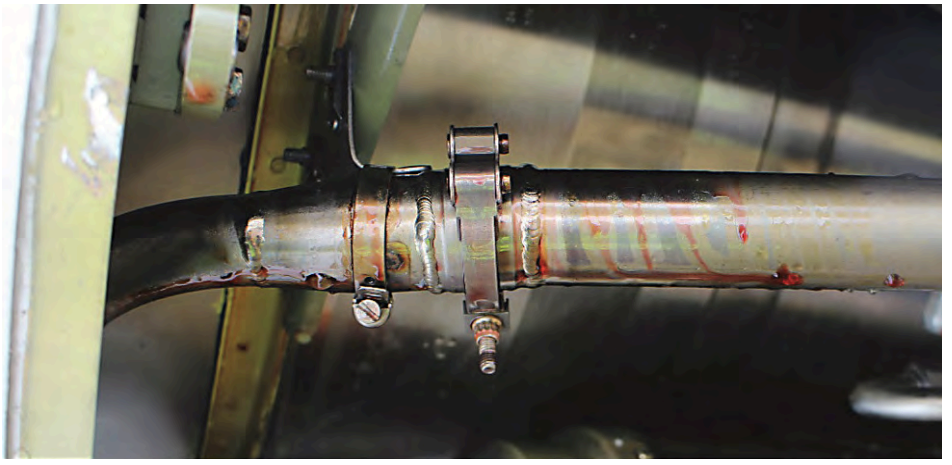
The report said that the crew did not realize that the aircraft had a total hydraulic system failure, which would require landing distance to be increased to 6,540 ft (1,993 m).

After attempting to extend the landing gear, the crew heard an aural warning indicating that the gear was not down and locked. They initiated a go-around, and the commander asked the copilot to conduct the 'Alternate Gear Extension' checklist.

"However, a few seconds later, before the copilot could action the checklist, the main gear indicated down and locked," the report said. "The commander disconnected the autopilot and continued the approach."

The copilot advised ATC that they had a hydraulic system problem and asked that aircraft rescue and fire fight-





Above: Hydraulic system leak spray dispersion within the left engine nacelle. © Raytheon

ing services be placed on standby. The aircraft touched down at 132 kt and about 1,500 ft (457 m) from the approach end of the runway.

"When the commander applied the toe brakes, he felt no significant retardation," the report said. "The commander later commented that he was in a 'state of panic' during the landing roll and was unsure whether or not he had applied the emergency brake." Investigators determined that the emergency brakes, which were not affected by the loss of hydraulic pressure, were not applied during the landing roll.

"When an overrun appeared likely, the commander shut down the engines, [and] the copilot transmitted a 'mayday' call to ATC," the report said. "The aircraft subsequently overran the end of the runway at a groundspeed of about 80 kt." The Premier was "damaged beyond economic repair" as it came to a stop on rough ground, the report said. The pilots and their two passengers were not injured.

Examination of the aircraft revealed that hydraulic fluid had leaked through a fatigue crack in the left hydraulic pump's port cap (a cover plate on a casing over the suction and pressure ports). ■

(The Flight Safety Foundation is an international non-profit organization whose sole purpose is to provide impartial, independent, expert safety guidance and resources for the aviation and aerospace industry.)

Aviation Services

Aviation Services

Aviation Services

Rules. Rules. More Rules.

Five years ago, there were two emissions schemes that required compliance by aircraft operators. Now there are five, and more are on the way. Here, Global Aerospace and its partner 4Air discuss compliance requirements.

Compliance schemes require aviation operators to annually monitor their international emissions.

EMISSIONS compliance is getting increasingly complicated for international operators and is likely to continue to do so. Simply put, compliance schemes require aviation operators to annually monitor their international emissions and, upon passing certain thresholds, report those emissions to the appropriate authority and purchase compliance credits to compensate for their reportable emissions.

1. What are some examples of existing emission schemes?
Today, operators must comply with a growing number of environmental schemes around the world. The Carbon Offsetting and Reduction Scheme (CORSIA), European Union Emissions Trading System (EU ETS) and the United Kingdom's version (UK ETS) cover various international routes, but a growing number of domestic schemes are also emerging. Such schemes exist in France and Turkey, and legislation may be passed in California. Regardless of their home country, operators flying to, from or within countries such as the U.K., Switzerland or any nation in the EU have to monitor their emissions and will potentially have reporting and compliance obligations.

2. What monitoring obligations exist for operators under these programs?
Any operator conducting international operations needs to monitor its emissions for potential reporting obligations. All of the programs have exemption thresholds. For example, aircraft weighing less than 5,700kg MTOW are exempt and different thresholds may apply for commercial versus non-commercial operators. However, it is recommended to monitor international emissions against all programs, particularly as the geographic scope, emissions factors and other rules are changing each year.

3. What reporting obligations exist under these programs?
CORSIA has a higher threshold than most schemes, but the ETS programs have thresholds for non-commercial operators that are low enough to be triggered by a typical flight department with high international flight volume to specific countries. A good rule of thumb is that if over 100,000 gallons of fuel are used annually on international missions, some compliance obligations are likely to be triggered.

4. Beyond reporting, what are the compliance obligations under these programs?
It can be confusing that the various emission schemes use different compliance mechanisms. CORSIA and the French ETS scheme use carbon offsets from the voluntary carbon market that meet specific requirements. Operators must purchase and retire these offsets against their carbon emissions. However, the EU, U.K. and Swiss ETS programs take more of a traditional cap and trade approach, issuing allowances specific to their program each year. Operators must buy the specific program allowances they need and surrender them to the state against their carbon emissions. ■

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