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AirMaintenance UPDATE

The Magazine for Aircraft Maintenance Professionals

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What Investigators Found

PAMA and AME news

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Breaking the ice

New research aims to keep planes and wind turbines ice-free

MOST OF US have had the rotten experience of sitting on a plane waiting for it to be de-iced knowing we will now miss a connecting flight. Help may be on the way as engineers at UBC Okanagan say they are collaborating with researchers from the University of Toronto on a novel de-icing system that works by combining an interfacial coating with an ice-detecting microwave sensor. This coating integrates the sensors into the material while enabling heat to dislodge ice without the need for a person or machine to physically melt it, explains UBCO's Dr. Mohammad Zarifi.

The research team calls their method a smart hybrid—meaning it's active and also passive. Active de-icing involves an external energy input used to remove the ice, typically through thermal, chemical or mechanical methods. In contrast, passive de-icing either reduces the accretion rate of ice, lowers the adhesion strength between ice and the surface or both.

"Our new technology takes a hybrid approach by adding sensors within an ice repellent coating that can easily be added to aviation or wind turbine blades," said Dr. Zarifi. The sensor acts as an ice detector which prompts the embedded heaters to melt the ice automatically.

"We are moving from our experimentation phase into real-life usage, and have seen the technology hold up to harsh conditions," said Zarifi. "We're currently working with Canadian turbine manufacturers to incorporate the technology for the upcoming winter." ■

— John Campbell, Editor

Departments

Features

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Unit 7, 11771 Horseshoe Way
Richmond BC V7A 4V4 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

Concorde Battery IA Renewal Series

Registration is now available for **Concorde Battery Corporation's 2023 Virtual IA Renewal Series** and the in-person IA Renewal event at Midlands Technical college in West Columbia, South Carolina. These free aviation maintenance training sessions are available for inspectors, maintenance professionals, pilots, operators, aviation professionals, students and enthusiasts.

Virtual Events

The Third Annual Virtual IA Renewal Series provides access to eight hours of maintenance training by prominent speakers worldwide from the comfort of your device. Distinguished speakers teach one-hour courses on Piston, Turbine and Rotorcraft specific topics. Each series runs for four hours over two days and is available in a morning (8 AM – 12 PM EST) and evening (5 PM – 9PM EST) session to accommodate global audiences. Each session is eligible for up to eight hours of IA and FAA Wings credit.

For more information on speakers and to register for a Concorde IA Renewal Series event: **www.concordebattery.com**

KEY DATES

Concorde Battery Piston Virtual IA Renewal Series
January 12 &13, 2023

Concorde Battery Turbine Virtual IA Renewal Series
January 19 & 20, 2023

Concorde Battery Rotorcraft Virtual IA Renewal Series
January 26 & 27, 2023

South Carolina IA Renewal
February 4, 2023
West Columbia, South Carolina

Honda unveils "very light jet" at NBAA 2022

Honda Aircraft chose the 2022 National Business Aviation Convention and Exhibition staged in Orlando, Florida in mid-October as the venue for unveiling its new HondaJet Elite II, which Honda says is the fastest, highest, and farthest flying aircraft in its class, and that it "redefines what it means to be a very light jet." Powered by twin GE Honda Aero Engines HF120s set in an over-the-wing configuration, the aircraft also features Natural Laminar Flow nose and wing, and composite fuselage. With 3,100 pounds (1,406 kilograms) of fuel the Elite II has an extended range of 1,547 nautical miles (2,865 kilometres) and an increased gross weight of 11,100 pounds (5,035 kg). A new avionics suite based on the Garmin G3000 integrated flight deck will offer several new features to reduce pilot workload including Stabilized Approach, Autothrottle and Autoland. ✪

COMING EVENTS

Buckeye Air Fair
February 17-19, 2023
Buckeye, Arizona
www.buckeyeaz.gov

Stars & Stripes Air Show Spectacular
February 26, 2023
Laredo, Texas
www.wbcaairshow.org

Sun 'n Fun Aerospace Expo
March 28-April 2, 2023
Lakeland, Florida
www.flysnf.org

Advertisers Index

STCs & new products

Pliers mitigate hand fatigue

The new **Talon Grip** long nose slip joint pliers from Snap-on Industrial have a diamond-serrated jaw that not only grips small items but provides up to a 57 percent increase in pulling power. The longer contoured cushion grip handle increases comfort, control, and leverage while requiring less hand pressure, mitigating hand fatigue. Its three position joint keeps the jaws parallel, increasing the surface area contact. Made from cold forged alloy steel, the sharp machined hardened teeth offer three different gripping geometries. **www.b2b.snapon.com**

Alternator tool simplifies coupling

Approach Aviation's new alternator coupling tools for Continental piston engines are purpose-built to make it easy for mechanics to inspect this critical component and simplify coupling installation and removal. The tool kit consists of a zinc-coated coupling spanner wrench and unique coupling gear socket with steel housing and aluminum gear engagement, designed to protect the steel coupling gear from damage during maintenance. Together, these tools allow the coupling to be held in place (mounted on the alternator or free-standing) while the coupling gear slippage is checked. **www.approachaviation.com**

Brackets offer weight savings

Greene Tweed's new thermoplastic composite brackets can endure the substantial demands of aerospace environments while offering significant weight savings over metallic parts. They are 35 to 50 percent lighter than competitive metallic components, making them an excellent replacement for metal materials. A proprietary compression molding system produces complex contour shapes for intricate geometry with molded-in features such as bushings or attachment points. The material meets fire, smoke, and toxicity safety requirements for interior aerospace parts, and offers excellent resistance to aerospace solvents, high temperatures, and high vibrations for extended component life. **www.gtweed.com**

ELT detects potential problems

Orolia is the first company to receive certification from Cospas-Sarsat and the European Union Safety Agency for its new-generation distress tracking emergency locator transmitter, the Ultima-DT. This product was developed in response to recent aviation safety mandates to improve global aircraft tracking. Unlike traditional automatic fixed ELTs and stand-alone units, the Ultima-DT is connected to the avionics system. It activates upon detecting a potential distress condition and starts transmitting automatically while the aircraft is still in flight. **www.orolia.com**

MIG welder is light and portable

Lincoln Electric's Power MIG 211i welder is a 200-amp machine for MIG, flux-cored, and spool gun welding. It is portable thanks to the sleek design with multiple lift points and inverter technology that reduces weight while maximizing power and ensuring more efficient operation. At 41 pounds, this machine can go anywhere and handle any job. The seven-segment display and basic knob controls enable you to get to welding quickly in a simple three-step process: 1) select welding process, 2) select wire diameter, and 3) select material thickness. **www.lincolnelectric.com**

Rapid charger reduces downtime

The **M18 PACKOUT** six bay rapid charger has the ability to rapid charge two batteries simultaneously, which means this new solution can charge six M18 REDLITHIUM XC5.0 battery packs in just three hours. Users can charge one battery at a time on each side of the charger, with charging then automatically moving sequentially to the next available battery as charging progresses. The increased charge speed reduces downtime spent waiting for batteries to charge, delivering more productivity with every charge. The USB-A port provides charging of personal devices like phones, headlamps, and flashlights. **www.milwaukeetool.com**

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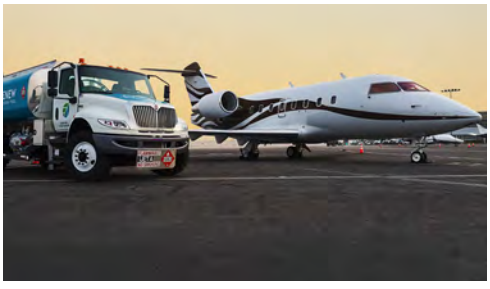
ULTRA EFFICIENT AIRBUS UNVEILED

Frontier Airlines unveiled its first ultra-fuel-efficient Airbus A321neo aircraft during a mid-October event at Tampa International Airport in Florida. The 240-seat A321neo powered by Pratt & Whitney's GTF engines will be the most fuel-efficient commercial aircraft among any U.S. airline, says Frontier. It will generate significantly lower carbon emissions and engine noise, and be the first of 158 A321neo's to be delivered to the low-cost carrier by Airbus between now and 2029. Frontier currently has 226 aircraft in total on order, which will nearly triple its fleet size by the end of the decade.

MILESTONE TURBOFAN ARRIVES IN TEXAS

StandardAero's San Antonio facility recently celebrated delivery of its milestone 100th Rolls-Royce RB211-535 turbofan engine less than two years after attaining full maintenance, repair and overhaul capability on the engine type. StandardAero entered into a life-of-type maintenance services partnership with Rolls-Royce on the RB211-535 in 2018, under which responsibility for in-service support of the engine is being transferred from Rolls-Royce's Derby, UK location to StandardAero's 810,000-square-foot facility in San Antonio. Generating up to 43,100 pounds of thrust, the RB211-535 powers the Boeing 757.



REGIONAL TURBOPROP TYPE CERTIFIED

Transport Canada Civil Aviation has now type certified Pratt & Whitney Canada's PW127XT-M regional turboprop engine that will power new builds of ATR aircraft. Revealed at the Dubai Airshow in November 2021, the PW127XT-M engine offers 40 percent extended time on wing, and 20 percent lower maintenance. In June, Pratt & Whitney Canada announced that Deutsche Aircraft had selected the PW127XT engine to power the new D328eco. The selected engine model – the PW127XT-S – will be developed according to the D328eco timeline.

BOMBARDIER REACHES SAF AGREEMENT

Bombardier and Signature Aviation have reached a multi-year agreement for the purchase of sustainable aviation fuel quantities, covering all of Bombardier's flight operations starting in January 2023. The agreement is the first of this scope for a business aviation original equipment manufacturer. "More of our customers are using SAF and so must Bombardier," said Jean-Christophe Gallagher, Executive Vice President Services and Support. "We must all share in the responsibility for a sustainable future. We believe that taking action today allows us to have maximum impact on the sector as a whole and on the production of SAF."

DEHAVILLAND PLANS ALBERTA PLANT

The Canadian Press has reported that De Havilland Aircraft of Canada has plans to build a new aircraft manufacturing plant east of Calgary, one that could eventually employ up to 1,500 people. The company said the facility is to be located in Wheatland County between the communities of Chestermere and Strathmore, Alberta. De Havilland said

it has acquired about 600 hectares of land in the area and that construction could begin as early as next year, with its first buildings operational by 2025. The plant is to be the site of final assembly for the DHC-515 Firefighter aircraft, DHC Twin Otter and the Dash 8-400 aircraft.

AMERICANS NEED BIGGER SEATS

More than 25,000 Americans have responded to the Federal Aviation Administration's request for comment to "assist the agency" in deciding whether minimum seat dimensions should be mandated in the name of safety. The 90-day public comment period ended in early November. Many people worried that being packed more tightly together would make it harder to evacuate in an emergency. FlyersRights, a passenger advocacy group, said that 40 years ago seat widths in typical economy cabins were between 19 and 21 inches; now they're between 16.5 and 18 inches. Compounding matters, since 1960, the weight of the average American has increased by nearly 30 pounds. Bigger seats... please!

FIRST TWIN WIDE BODY CELEBRATES

This fall saw a significant milestone for an important aircraft. October 28, marked the 50th anniversary of the world's first twin engined widebody commercial aircraft, the A300B1 development aircraft, MSN 1. Bearing the registration F-WUAB, the A300B1 performed its maiden flight in Toulouse, France in 1972. The flight lasted 85 minutes during which a maximum speed of 185 knots was reached at an altitude of 14,000 feet. Autopilot was engaged, moving surfaces were tested and landing gear retraction and deployment were performed. Upon return to Blagnac airport, strong wind gusts, the famous Toulouse "Vent d'Autan," required a controlled crosswind landing.

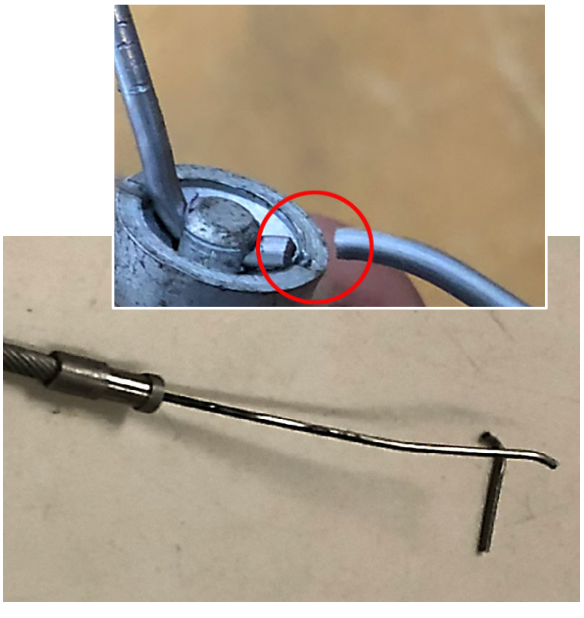
OIL RECYCLING CENTRE OPENS

Looking for a used oil drop-off centre? BC Used Oil Management Association, a not-for-profit group dedicated to the collection and recycling of used motor oil, oil filters, oil containers, used antifreeze and antifreeze containers in British Columbia, has opened a new, used oil recycling centre at the Central Surrey Recycling and Waste Centre on the Lower Mainland. Through a partnership with Metro Vancouver, BCUOMA provided the new location with a 20-foot modified sea container and two 1,000-litre intermediate bulk containers to manage the responsible collection and storage of returned used oil and antifreeze materials. ■

TC Feedback

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

Above: A Piper PA-23 Aztec.
Below: Fracture located at swivel fitting connection.
Bottom: Broken fuel selector valve control cable inner wire.



REPORTS AND COMMENTS

Report: Piper PA-23 Aztec
Fuel Selector Valve Control Cable Failure at Swivel Fitting

Subject:
Engine surging and loss of power during flight due to a fuel supply problem.

Transport Canada Comments:
The engine power loss occurred during flight in the right-hand engine when the pilot selected the inboard fuel tank, as the outboard fuel tank capacity had been exhausted. An emergency was declared with the intention to land as soon as possible. While troubleshooting, the electric boost pump was turned on with no effect. The pilot utilized the fuel cross-feed system from the left-hand engine, which provided fuel supply and returned the right-hand engine power back to normal. The aircraft landed safely shortly thereafter.

The Federal Aviation Administration (FAA), the State of Design for the product, published Airworthiness Directive

Above: A SAAB 340B in flight.
Left: The axle with the remainder of the wheel bearings after the wheel departed the aircraft on takeoff.

(AD) 80-18-10, which requires inspection of all fuel selector valve control cables using 10x power magnification each 100 hours. Piper Service Bulletin No. 507 has been referenced within the AD for specific inspection locations, highlighting all swivel fittings.

Although the fuel selector valve control cable had been recently inspected prior to the incident, the defect was not uncovered at that time. The fuel selector valve control cable inner wire fractured under the crimping cup of the swivel fitting. It is important to remain vigilant and avoid complacency when completing all maintenance, with special attention to the requirements of an AD.

Report: SAAB 340B
Nose Wheel Bearing Failure

Subject:

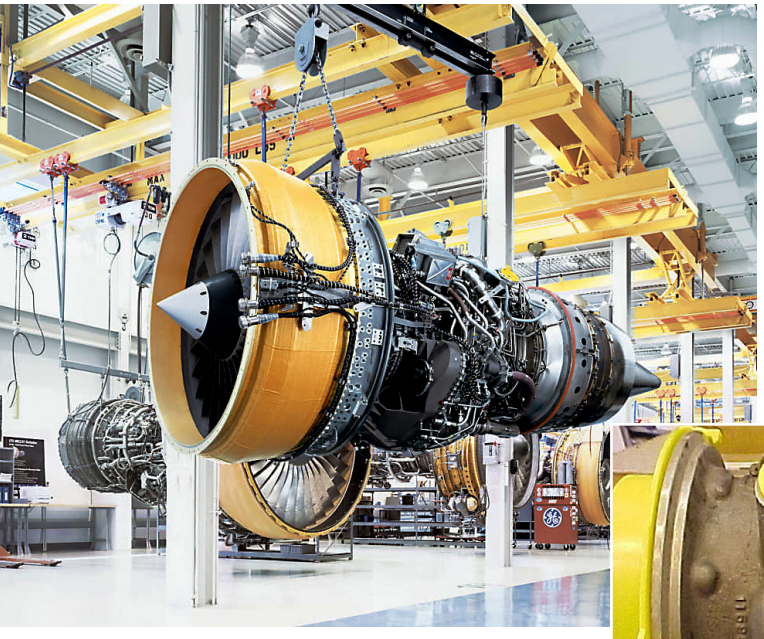
The pilot conducted a scheduled flight. During regular rollout, the pilot felt an unusual and violent vibration from the nose landing gear upon rotation. As the gear retracted, the noise and vibration went away and the takeoff carried on as usual. The pilot called the tower to check the runway to see if there was a possibility that the nose wheel might have fallen off. A few minutes later, the tower confirmed that they found a wheel.

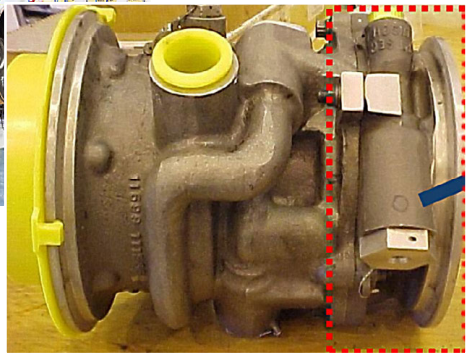
The pilot continued the flight, declared an emergency with the air traffic control centre and advised that he would be conducting an emergency landing. The pilot requested a low pass to get a detailed description of the integrity of the landing gear. The tower confirmed that the right front wheel was missing, and the left front wheel was still in place.

The pilot conducted an emergency landing. The maintenance crew inspected the nose landing gear and found that the nose wheel assembly bearing mount was still on the nose landing gear axle. The nose wheel axle was damaged. Upon inspecting the nose wheel bearing, it was suspected to be inadequately greased, causing bearing failure.

Transport Canada Comments:

There have been a number of wheel bearing failures on a number of different aircraft models. Maintenance personnel are advised to ensure that wheel bearings are properly greased and torqued to specifications published by the manufacturer.



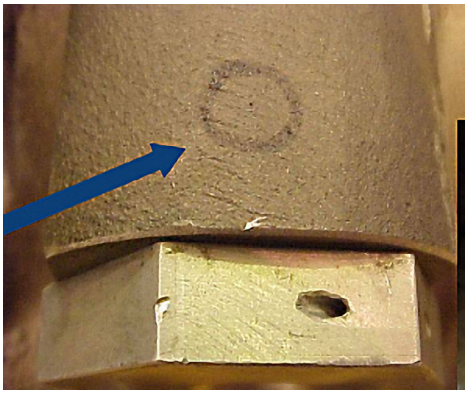


General Electric: Above, and Right: Main fuel pump secondary housing. Below right: Pinhole at secondary housing.

Report: General Electric CF34-3B1 Engine Main Fuel Pump

Subject:

During a routine inspection, fuel was discovered in the lower engine cowl. Upon further investigation, it was discovered that the engine-driven fuel pump had developed a small pinhole in the inlet case allowing boost pump pressure to leak from the pump body. The affected pump was replaced, and the aircraft returned to service.



Transport Canada Comments:

We have received several Service Difficulty Reports (SDRs) related to fuel leaks from a pinhole on this particular fuel pump part number. The leakage is attributed to a pinhole on the relief valve wall of the secondary housing as a result of erosion caused by the effect of cavitation over the relief valve cavity threads. These leaks may be barely detectable due to the size of the pinhole.

General Electric added inspection instructions in the component maintenance manual to check for cavitation on the secondary housing and issued Service Bulletin (SB) 73-0050 R00 identifying new spare parts for a redesigned main fuel pump with rerouted passageways.

Transport Canada Civil Aviation (TCCA) would like to make operators and maintainers of similar models aware of these events, and urges everyone to be vigilant while inspecting the fuel pump area for leaks.

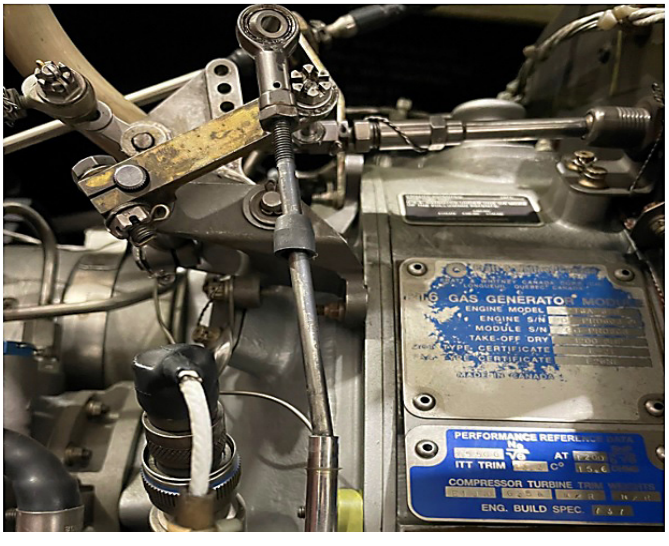
Report: Pilatus PC-12/47 Power Control Lever – Production Issue Advisory

Subject:

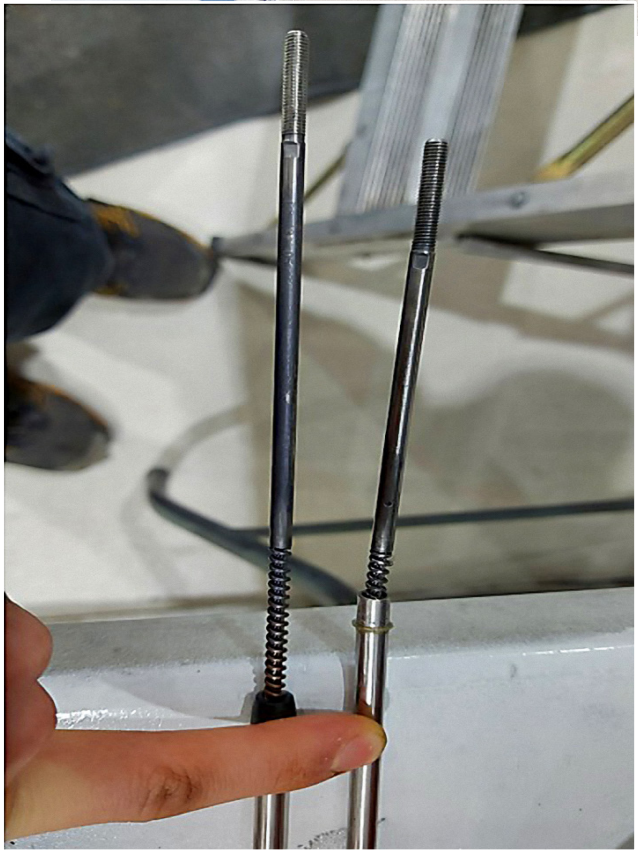
A new power control cable assembly part number (P/N) 941.94.11.437 was installed. The crew started to comment that the power control lever was jamming when selecting full reverse. Upon investigation, we realized that when full reverse was selected, the power control cable was binding because the flex core of the cable was barely exposed. Thus, there was no longer any support from the cable liner to the inner part (unable to push without sideway play).

When selecting full travel (going to reverse), the power control cable rod end would over centre, and going out of reverse became difficult. On the previous power control cable, P/N 941.94.11.419, there was at least one more inch of solid portion of the cable. Pilatus provided a drawing of the power control cable, P/N 941.94.11.437, and the dimension of the rod end portion of the cable was 25 mm shorter on the newly installed power control cable assembly, P/N 941.94.11.437, than on the drawing. Pilatus noticed a production issue with this new power control cable and provided a replacement part under warranty.

Below: Pilatus PC-12/47, Cable deflection when fully extended.



Left: Pilatus, Below left: Difference in cable length from old (left) to new (right).



Transport Canada Comments:

This Feedback Article aims to make PC-12 aircraft operators aware of the production issue of this power control cable assembly, P/N 941.94.11.437. Maintainers should be vigilant when replacing the power control cable and performing the prescribed functional checks of the system.

Any operator that finds a similar defect to the one described within this article, should submit a Service Difficulty Report (SDR) to Transport Canada through the Web Service Difficulty Reporting System (WSDRS).

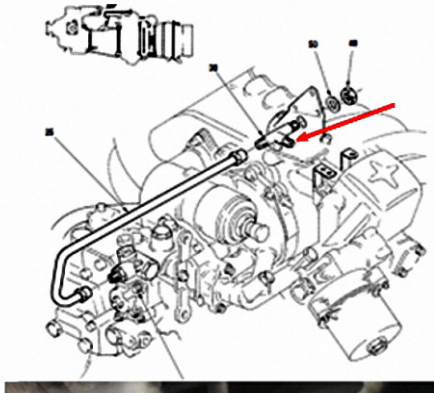
Report: Pratt & Whitney PW127M Disconnected Fuel Line

Subject:

During a routine power assurance check, the left engine caught fire.

Transport Canada Comments:

The investigation of this event determined that the fuel pressure line had been disconnected during the



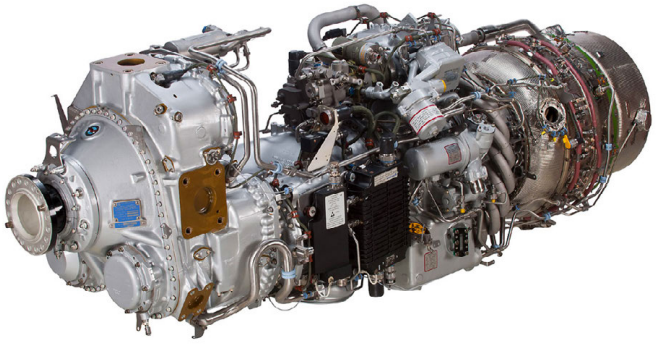
PRATT & WHITNEY. Disconnected fuel line.

removal of the nacelle lower structure. This is a deviation from the airframe manufacturer's procedures, and disconnection is not required. Following scheduled maintenance, a leak check was not performed before the power assurance check was carried out. A review of the Engine Maintenance Manual (EMM) and Airframe Maintenance Manual (AMM) found nothing wrong with the procedures for the task.

The described event perfectly shows how failure to follow manufacturers' Instructions for Continued Airworthiness (ICA) can lead to very serious situations. Not only did omitting steps lead to problems, but the additional step of disconnecting a fuel pressure line resulted in an engine fire. If a ground run had been performed post-maintenance, this event may have been prevented.

Transport Canada Civil Aviation reminds operators and maintainers to strictly adhere to ICA, perform ground runs after maintenance, and have a colleague check the work performed before closing panels or doors.

A Pratt & Whitney PW127M engine



A Canadair Challenger

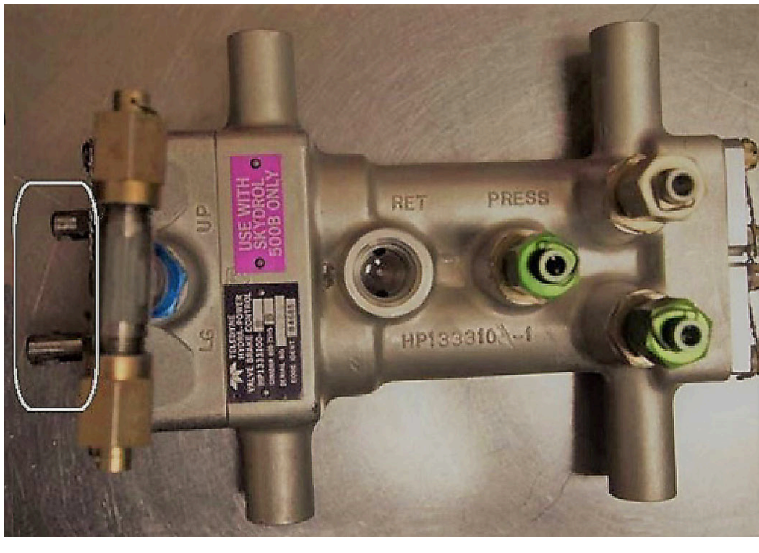
Above: Close up of a broken spring of the BCV.

Report: Canadair Challenger CL600 2A12 Brake Control Valve Loss of Braking due to Failure of Internal Spring

Subject:

During an investigation of an aircraft landing overrun, the dual BCV, Tactair part number (P/N) HP1333100-9 (Bombardier P/N 600-75115-9), was found with a broken spring that reduced the brake pressure to the #2 brake. The #2 BCV (position left inboard) was shop tested and found that the brake performance was degraded as the output pressure was 150 psi instead of the normal pressure of 2850 to 3000 psi. During the pre-disassembly visual inspection, the input plunger (rod) on the BVC was found to be recessed and was asymmetrical when compared with the adjacent input plunger (rod). The vendor found that the root cause of this condition was determined to be a broken power brake spring inside the valve assembly.

Below: BCV showing misalignment of valve plunger positions.



Transport Canada Comments:

The final accident report for this incident found that the failed BCV (broken spring) was one of a number of contributing factors to the runway excursion. The report also con-

cluded that the BCV spring failed (due to fatigue) during the incident as braking operation had been normal on the previous landing.

BCVs with broken springs have only been reported twice within the combined fleet of CL600/601 and RJ100/200 aircraft models, which use this same part. There have been a number of instances where relaxed springs have been found, but these occurrences have never contributed to a runway excursion due to lack of braking. The BCV brake pressure with a relaxed spring is less than rated maximum, but more than sufficient to stop the aircraft per the published landing distances.

Maintainers and operators should investigate any brake pedal issues reported by the crew as BCVs with high time in service may be prone to spring breakage. To check the integrity of the internal brake valve spring, depress both brake pedals and release. Then perform a visual inspection of the BCV with a light and mirror to confirm the brake valve plungers contact the brake levers. If both valve plungers are contacting the levers, the brake springs are not broken.

The CL601 model aircraft can be maintained on either a MSG-2 or a MSG-3 maintenance program. The accident aircraft was using the MSG-3 program. During the investigation, it was discovered that CL601 aircraft on the MSG-3 program do not have the same inspection task for the BCV as required in the MSG-2 program. The MSG-2 program requires an inspection of the BCV at a 300 hour interval per task 32-43-21-216, whereas the MSG-3 program does not use this task. After review of the aircraft inspection program requirements, Transport Canada is planning to mandate this inspection task on all Challenger 601 model aircraft with an Airworthiness Directive (AD). The AD will add an inspection task to the CL601 aircraft MSG-3 program and have no effect on the MSG-2 aircraft as they are already performing this inspection task. ■

Flight Data Recorder:

Facts and Future

From its invention and throughout its evolution, the 'black box' has been crucial for maintaining and improving commercial aircraft safety since the 1950s. Here, component supply specialists Artemis Aerospace explores this essential piece of equipment and how it has developed into the modern technology used by the industry today.

Left: The earliest known flight voice recorder design was made by François Hussenot.

Below: In 1943 the US air force conducted an experiment with a magnetic wire recorder to capture the inter-phone conversations of a B-17 bomber flight crew on a combat mission over Nazi-occupied France.

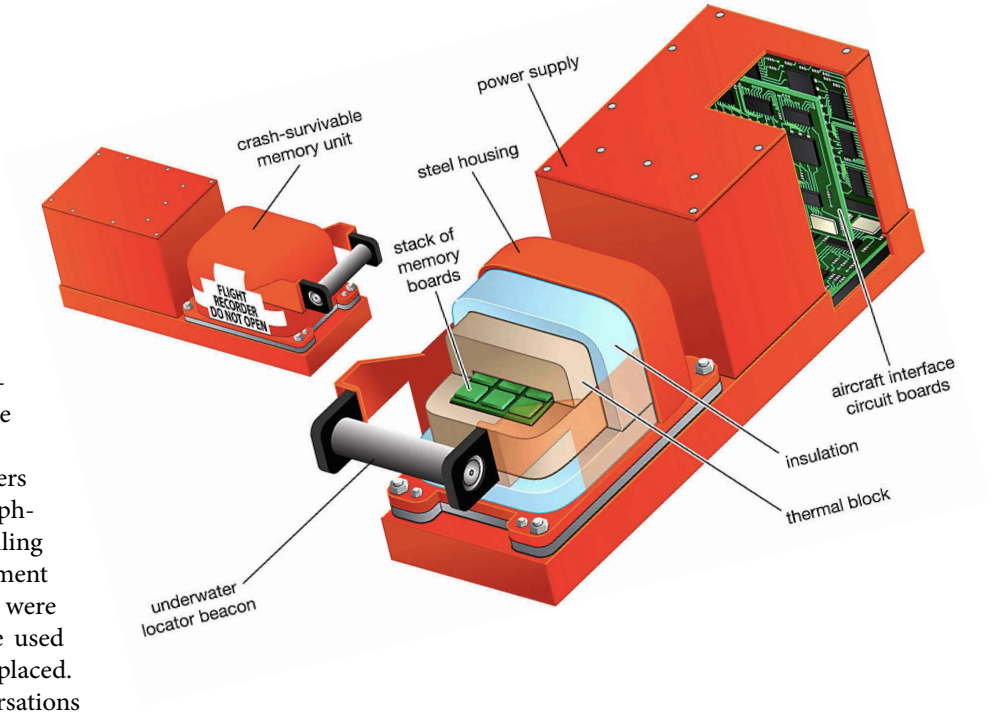
COMMONLY referred to as a 'black box', the device's official name is flight data recorder (FDR) or cockpit voice recorder (CVR). Originally, flight recorders consisted of magnetic tape encased in a fireproof box that was painted black to protect the metal and prevent rust, hence the terminology 'black box' – an expression that was made popular by the British during World War Two. However, after FDRs were mandated by the aviation industry in the 1960s, regulations stipulated that all flight recorders must be painted in 'international orange' – making them highly visible and easy to distinguish in the event of an incident.

BUT WHERE DID THE BLACK BOX CONCEPT COME FROM?

Early flight recorders

Although the Australian scientist, David Warren, is credited with inventing the first flight and voice recorders for the commercial aviation industry, the earliest known design was

Above: Tape recordings eventually became digitized as the FDR and CVR combined into one unit.



Right: Components of a black box include an underwater locator beacon and other insulated circuits crucial to operations.

made by François Hussenot and Paul Beaudoin at the Marignane flight test centre in France in 1939.

The 'Hussenograph' as the engineers called their invention, was a photograph-based flight recorder that used scrolling photographic film and recorded instrument data, such as altitude and speed. There were disadvantages: each film could only be used once, after the mission it had to be replaced. The recorder did not record any conversations at all. Consequently, the device was rarely used, except on test flights.

Still, Hussenot's and Beaudouin's legacy lives on through the Société Française des Instruments de Mesure, which they founded in 1947 and today forms part of the multi-national manufacturer of aircraft engines and equipment, Safran group.

During World War II, Len Harrison and Vic Husband developed a crash and fire-proof flight recorder for the Ministry of Aircraft Production, setting the standard for today's modern units.

The first flight recorders for commercial aircraft

Up until the 1950s, flight recorders were primarily used on military aircraft. However, in 1953, David Warren's prototype FDR 'The ARL Flight Memory Unit' was specifically designed for post-crash investigations of civilian aircraft and was the first to record voices in the cockpit as well as instrument readings.

The construction was a simple but careful design: a thin steel wire, as used at the time in modern recorders, was mag-

netized by an electrically controlled writing head. In this way, the pilot's conversations and up to eight flight data per second could be recorded. After four hours, the loop began again, the data was overwritten. Warren encased the complete construction in a shockproof housing.

Above: The disappearance of Malaysia Airlines Flight 370 in March 2014, demonstrated the restrictions of flight recorder technology.

Left: Workers search for a downed aircraft's black box.

Actually it was the recording of cockpit sounds that proved to be, arguably, Warren's best idea. While mechanical problems can be detected relatively quickly on flights due to the large amount of processed data (modern flight recorders can store more than 1,000 parameters), sounds from the cockpit have proven revelatory to investigators.

A good example was TWA 800, which exploded mid-air east of New York, in July 1996. On the tape, less than a second before the crash, two insignificant noises were heard with a pitch of 400 hertz —a frequency that also powers the aircraft. It was only these tones that led investigators to believe two short circuits in the fuel gauge must have sparked an explosion in the jet's main tank.

Sometimes the recordings simply show the desperation, confusion, and helplessness of the flight crew. Such an example occurred during the 1996 crash of a Boeing 757 belonging to Turkish charter airline Birgenair, in which 189 passengers going on vacation were killed off the coast of the Dominican Republic. An error in the pitot tube static system reading provided the autopilot and crew wrong speed values. During the incident, the captain sounded completely confused and unnerved. Despite the mechanical failure, the final investiga-

Above: After FDRs were mandated by the aviation industry in the 1960s, regulations stipulated that all flight recorders must be painted in international orange.

tion report—which took the cockpit records into account—ultimately blamed the pilots for the disaster.

As recordings became digitized, the FDR and CVR combined into one unit called the CVDR. Most commercial jets are now additionally equipped with a QAR (quick access recorder) meaning data can be easily removed and accessed quickly in the event of less serious incidents, such as unplanned deviations, that require further investigation.

Right: Investigators recover the flight data recorder of Atlas Air Flight 3591, a Boeing 767-300 cargo jet that crashed in marshland near Houston, Texas.

Below: Most commercial jets are now additionally equipped with a quick access recorder meaning data can be easily removed and accessed quickly in the event of less serious incidents.

Today's systems include built-in test equipment and diagnostics that records how the aircraft is operating. This means that potential issues can be identified and dealt with before an incident occurs, making air travel even safer and more efficient than ever before.

Flight recorders become mandatory

Following the crash of Trans Australia Airlines Flight 538 in 1960, Australia became the first country in the world to make cockpit voice recorders mandatory. In 1964, the United States passed its first cockpit voice recorder rules requiring all turbine and piston aircraft with four or more engines to install CVRs by March 1967. By 1967, FDRs had become mandatory in many countries. Commercial aircraft were required to carry FDRs and CVRs housed in bright orange boxes in the tail of the aircraft, where they would stand the best chance of survival in the event of a crash.

FDRs are now governed by ICAO (International Civil Aviation Authority) and the FAA (Federal Aviation Authority) in the United States. These regulators stipulate the specifications and standards FDRs must meet for aircraft. This includes FDRs being equipped with an underwater locator beacon that is automatically activated when an incident occurs.

FDR improvements and updates

Despite the introduction of the underwater locator beacon to aid FDR recovery following a crash, the technology was not without its limitations. Notably, the disappearance of Malaysia Airlines Flight 370 in March 2014, demonstrated the restrictions of flight recorder technology, which required physical

François Hussenot's Société Française des Instruments de Mesure, founded in 1947, helped form today's Safran Group.

possession of the device in order to understand the cause of an accident.

Unable to locate Flight 370 or its FDR, authorities called for live streaming of data from the aircraft to the ground. In addition to this, they requested for the range and battery life on all underwater locator beacons to be extended and that aircraft be fitted with a secondary deployable recorder that would be ejected from the aircraft before impact.

FDRs of the future

Artificial intelligence and telematics are leading the way in developing the aircraft of the future, including improving the collection of in-flight data and voice recordings. Honeywell's latest flight deck, Anthem, provides anytime, anywhere data analytics and an engine-out function to automatically guide pilots to the nearest airport, while assessing factors such as terrain and wind speed.

The NTSB (National Transport Safety Board) in the US has long been lobbying for installing cockpit video recorders in new and in-service commercial jets to improve the quality of information that can be gathered following an incident. However, this hasn't been without controversy and ALPA (Air Line Pilots Association) has expressed concerns regarding privacy.

Whatever the future holds for flight data recorders, they will continue to be essential to maintaining safe air travel for all passengers. ■

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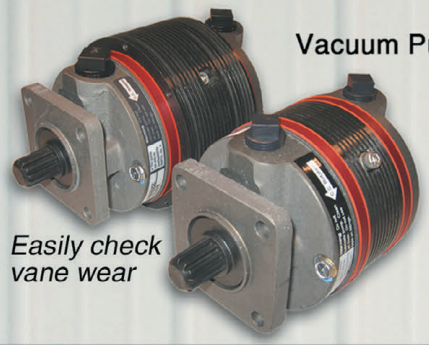

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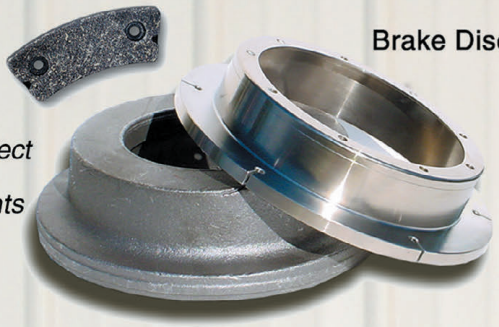

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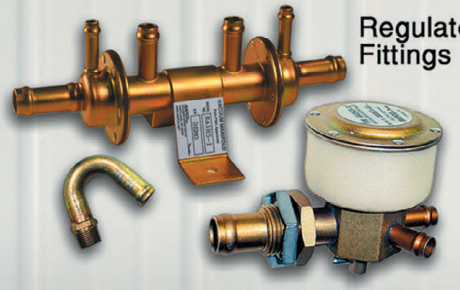

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PACIFIC

Pacific AME Association

Corporate Members

Our corporate members are important to us. From supporting / sponsoring the Association's workshops to donating boardrooms for our meetings and training, we appreciate their hard work and dedication to furthering the industry.

Corporate benefits

Work shop and meetings during the year on topics of interest to AMEs.
Opportunity to meet and exchange ideas at our functions.
A representative of a corporate member has the right to attend and speak at all membership meetings, but is not entitled to vote or to hold office in the Association.
Corporate Members are entitled to advertise that they are members of AME Association.
Opportunity for employment networking at our workshops.
Free advertising of your company on our website.
Free job postings on our website.
Two corporate members able to attend our workshops.
www.amec-teac.ca/pacific

WESTERN

Western AME Association

Are you satisfied?

Aircraft imports and exports (transitions) require a clear understanding of the type certificate and continuing airworthiness. Mastering this knowledge and being able to execute all that's necessary to prepare for the TCCA MD-M or FAA DAR (EASA, etc) is the pinnacle of licenced AME competence with respect to airworthiness, but is not recognized by TCCA licensing standards. TCCA assumes every licenced AME has the airworthiness knowledge and competency necessary when licenced.

The FAA system requires an A&P mechanic to work for 5 years, attend an Inspector Authorization course, pass an exam, and maintain the qualification with recurrent training in order to perform and release an annual inspection. The IA is an inspector qualification.

We also see professional engineers in positions that impact CARs compliance with no CAR's (airworthiness) competency yet they are often considered better suited for jobs that exclude AME's (without an engineering degree) who have the knowledge and experience to qualify, but no professional recognition for their competency.

Are you satisfied with the current Canadian AME qualifying and licensing system? What can be improved? What do you like about the current system?
Due to our website crash, please temporarily email WAMEA at: **md@werkasset.com**
www.wamea.com

CENTRAL

Central AME Association

Symposium Keynote Speaker Announced!

CAMEA is thrilled to announce the confirmation of our 26th Annual Aviation Symposium Keynote Speaker, Kendra Kincade, who is the Founder and Chief Executive Officer of Elevate Aviation, a non-profit organization dedicated to introducing more women to careers in the aviation industry. Under Kendra's leadership, the organization has secured over $1.5 million in funding within a few years to support programs that emphasis the dynamic industry to women.

Kendra and her team have created programs such as the Canadian Cross-Country Tour with 20 stops across Canada and growing, the Elevate Aviation 'Explore Aviation Weeks' in Alberta, The Elevate Aviation Learning Centre, a 5 tier mentorship program, and more.

The 26th Annual Aviation Symposium is on March 2-3, 2023! Early bird discounts in effect before February 5, 2023. Save 10 percent.

Event Venue:
Canad Inns Destination Centre Polo Park
1405 St Matthews Ave
Winnipeg, Manitoba

Event Schedule: Thursday
0745 to 0900 Registration & Continental Breakfast in Trade show area
0900 to 1530 Speakers & Presentations / Trade Show Open
15:30 to 16:30 Skills competition
1630 to 1830 Banquet Reception on-site in the TYC Event Centre
1830 to 2100 Banquet in TYC

Event Schedule: Friday
0745 to 0900 Registration & Continental Breakfast in Trade show area
0900 to 1630 Speakers & Presentations / Trade Show Open until 1400 (Booth tear down @ 1400)

Event Speakers:

Thursday, March 2
Key Note Speaker: Kendra Kincade - President of Elevate Aviation
Pending Special 1 Day Course (Pre-registration required, limited capacity)

Friday, March 3
Pending Special 1 Day Course (Pre-registration required, limited capacity)

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

2022 Ontario Aircraft Maintenance Conference

The 2022 Ontario Aircraft Maintenance Conference was a great success with the attendees participating in 34 training sessions and visiting the 65 exhibitor booths. The conference was opened on Wednesday morning with welcoming remarks by Imi Waljee, AME, the Transport Canada Regional Director, Civil Aviation – Ontario. The opening session was enhanced by a presentation by Gordon Dupont, the father of the "Dirty Dozen," who expanded upon the conference's theme of Performance, Professionalism & Pride.

2022 AME Skills Challenge

One of the most anticipated events of the year is the AME Skills Challenge. This year we had 11 teams competing through 10 challenges to garner the most points to win.

Each team consisted of three seasoned AMEs aided by one student assigned from the volunteer pool. Events were timed and the results judged by the corporation that supplied the challenge.

Congratulations to: first place winners – RCAF Team # 3; second place – Air Canada Team # 2; and, third place was the team from Chartright. On the Sunwing Team was student Hitesh Sharma Burgus. He won the prize of top student for which he was presented an endorsement course from FlightPath International. Advanced Composites Training also presented him with a $1,000 training course for the best score in the composite challenge.

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.

Faire partie d'une association régionale de TEA amène certains avantages. Outre l'accès à des rabais intéressants pour les TEA, vous recevrez plusieurs magazines dédiés au monde de l'aéronautique directement à la maison. C'est aussi un excellent moyen pour les TEA de participer à cette communauté.

Nous avons récemment été actifs à différents niveaux et avons eu le plaisir de participer à la journée Portes-Ouvertes de l'École nationale d'aérotechnique de St-Hubert le 19 novembre et avons eu la chance d'y rencontrer nombre de futurs étudiants souvent accompagnés de leurs parents. De plus, le 20 et 21 novembre derniers, les 6 associations régionales de TEA du Canada se sont rassemblées à Ottawa en présentiel pour la première fois depuis l'assouplissement de certaines restrictions relatives à la Covid-19. Nous y avons également rencontré les représentants du département de la Navigabilité opérationnelle de Transports Canada pour notre réunion annuelle avec eux. Nos membres recevront sous peu un compte-rendu complet de cette rencontre.

Finalement, nous prévoyons organiser notre assemblée générale au début de 2023. Les membres seront informés par courriel relativement à cette rencontre.

Vous pouvez en apprendre plus à notre sujet à l'adresse suivante :
www.ame-tea.com email: info@ame-tea.com

We are the Aircraft Maintenance Engineers Association of Quebec, and we are proud to be able to serve and promote the AME community in Quebec. As a member of the AMEC/TEAC, we work with various AME Associations across Canada on various files, some of which work directly with Transport Canada.

The Quebec AME Association holds in high regard the safety of those persons affected by the Aviation Maintenance occupations, to promote safe practices in the workplace and to recognize that safety is the cornerstone of the aviation industry.

Being part of a regional AME Association brings certain advantages. In addition to access to attractive discounts for AMEs, you will receive several magazines dedicated to the world of aeronautics directly at home; an excellent way for AMEs to participate in this community.

We have recently been active at different levels and had the pleasure of participating in the Open House Day at the École nationale d'aérotechnique in St-Hubert on November 19 and had the chance to meet many future students there, often accompanied by their parents. In addition, on November 20 and 21, the six regional AME Associations of Canada gathered face-to-face in Ottawa for the first time since the relaxation of certain restrictions relating to Covid-19. We also met there with the representatives of the Operational Airworthiness Department of Transport Canada for our annual meeting with them. Our members will soon receive a full report of this meeting.

Finally, we plan to organize our general meeting in early 2023. Members will be informed by email about this event. Learn more :
www.ame-tea.com email: info@ame-tea.com

ATLANTIC

Atlantic AME Association

Xenia Morales Women in Aviation Scholarship

Forrest Protection Limited is excited to announce the recipient of the 2022 Xenia Morales – Women in Aviation Scholarship to Sarah Holtzheimer. After completing the Georgian College Aviation Management program in Barrie, Ontario, in 2015, Sarah worked at the Romeo Leblanc Moncton airport for three years as Passenger Services Agent and was promoted to Ramp Crew Chief. Also, she is a recent graduate of the College of The North Atlantic as an Aircraft Maintenance Engineering Technician. She was selected to be the 2022 Valedictorian in her graduating class.

The scholarship is presented to an exceptional student from New Brunswick in recognition of their accomplishments, and as encouragement and support for their success in a career of either Pilot or Aircraft Maintenance Engineer Apprentice.

We would like to wish Sarah much success as she embarks in a new career in aviation.

Potential phishing scam alert

To our members: It's been brought to our attention that there could be Phishing emails circulating that appear to be coming from the Association President, Bob Pardy. Please be vigilant and do not open if it appears suspicious.

www.atlanticame.com

SOCAL

SoCal PAMA Chapter

About PAMA chapters

The various chapters of the Professional Aviation Maintenance Association provide opportunities at the local level for networking, education, and involvement in the aviation maintenance industry. PAMA is divided into six regions, each with a Regional Director. Regional Directors liaison with chapters in their region and represent regional and chapter interests to the PAMA Board of Directors. Contact the local chapter in your region and get involved. These regions include:

Central Region

The central region includes Iowa, Kansas, Missouri and Nebraska.

New England/Eastern Region

The Eastern Region includes Connecticut, Delaware, District Of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia

Great Lakes Region

The Great Lakes region includes Illinois, Indiana, Michigan, Minnesota, North Dakota, Ohio, South Dakota, and Wisconsin

Northwest Mountain Region

The Northwest Mountain region includes Colorado, Idaho, Montana, Oregon, Utah, Washington and Wyoming

Southern Region

The Southern region includes Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina and Tennessee

Southwestern Region

The Southwestern region includes Arkansas, Louisiana, New Mexico, Oklahoma and Texas

Western Pacific Region

The Western Pacific Region includes chapters in Arizona, California, Hawaii, and Nevada

SoCal PAMA Board of Directors

www.socalpama.org

Central Ohio PAMA

Why Form A Chapter?

PAMA's dedication and commitment to the aviation industry begins with providing the tools and support for ensuring a strong aviation maintenance workforce infrastructure. The trade group brings together maintenance technicians, manufacturers, suppliers, educators and students in successful pursuit of their goals in the aviation industry. This page provides information in support of local leaders.

PAMA chapters offer:

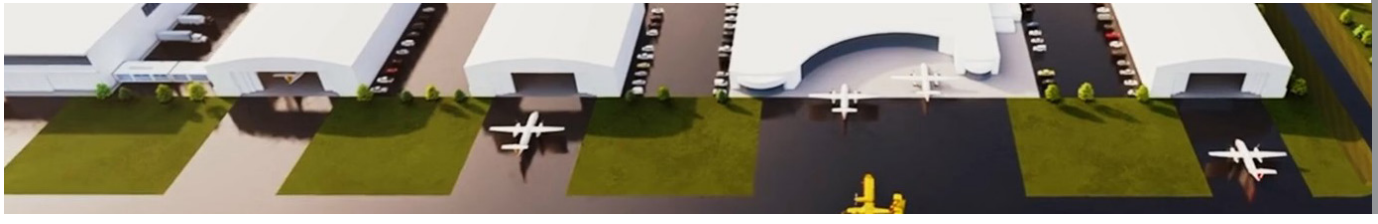
Educational programs
Networking opportunities
Increased political power to respond to regulatory and legal issues
Timely, industry-related Information
Scholarship opportunities
Technical resources

The combination of these products and services offers aviation maintenance professionals the opportunity to improve their skills, save their companies money and contribute to the advancement of the aviation industry.

Steps to start a chapter

Review chapter obligations
Establish the geographic area the chapter will serve
Identify at least 10 PAMA National members that will act as members and officers of the chapter
Submit a chapter application
Upon approval create bylaws

www.copama.org



FOUND
What Investigators

Whether the cause is mechanical failure or human error, every aircraft accident requires an investigation. What investigators find can often be surprising and even alarming. DVI Aviation, which specializes in aircraft accident investigation and reconstruction, has compiled snapshots from some of their recent case studies.

Failure to annotate. During an overhaul the mechanic converted the engine from one model to another, but did not annotate the engine data plate.

Failure to Annotate

AN aircraft owner purchased an engine from a salvage yard, and had it field overhauled. During the overhaul the mechanic converted the engine from one model to another, but did not annotate the engine data plate. During annual inspections nuts were consistently found to be loose, including the prop to crankshaft flange attachment. Ultimately, the number two cylinder departed the engine in flight, and the pilot made a successful off field landing without injury. DVI's material sci-

ence expert was retained to examine the cylinder base studs and thru-bolts that failed. DVI discovered that incorrect and mismatched connecting rods were installed, as were incorrect cylinder base nuts, and the prop STC was not approved for the original engine model number. Examination found the failed bolts were consistent with a fatigue failure associated with loss of pre-load. Fretting found on many other surfaces also suggested that a gradual loss of pre-load could have been occurring due to the excessive vibrations created by improperly balanced crankshaft and unapproved propeller installation.

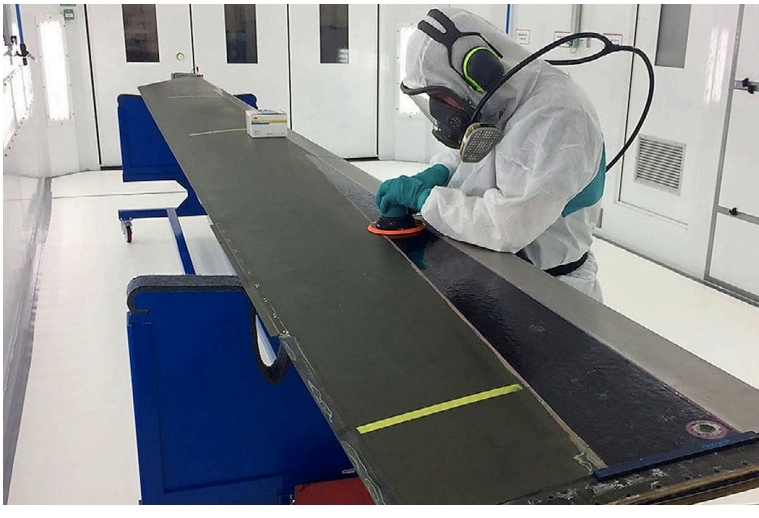
Aftermarket found Inadequate

A certified aircraft was destroyed during an on-ground fire following an emergency descent and landing due to an in-flight fire. The left exhaust stack assembly contained an approximately four-inch fracture around the main collector welded joint. The left exhaust stack assembly was manufactured by an aftermarket company that reverse engineered an OEM part and obtained an STC. DVI's aviation experts examined the wreckage, and made a comparison between the aftermarket part and the OEM. The design of the OEM exhaust stack assembly was found to differ significantly from the comparable aftermarket, which was inadequate to carry the load of the turbocharger attached to the manifold. The weld fatigued and failed due to the unintended bending stresses.

Overhaul long Overdue

A regional airline mechanic was troubleshooting a claim by passengers that smoke was coming up from the floor during the flight. Under the floor there are two air conditioning packages or "packs" for air conditioning and pressurization. Each distribution system has fans and filters in the recirculation ducting to clean and condition the air. To troubleshoot the issue, the mechanic removed the floor access panels and activated the air-conditioning units. While observing the operation of the packs, the mechanic's eyes were exposed to smoke containing super heated particles. DVI's aircraft maintenance expert evaluated the maintenance protocols of the maintenance shop and evaluated the failed pack. It was determined the mechanic ignored safety protocols and was not wearing eye protection, and that the fan motor brushes were found to be 500 hours

Left: Aftermarket found Inadequate. A weld fatigued and failed. Below: Overhaul long Overdue. While observing the operation of the packs, the mechanic's eyes were exposed to smoke.



Above: Composite Rotor Blade Failure. DVI's helicopter maintenance and composites experts were retained to defend the rotor blade overhaul shop.

over the required Time Between Overhaul (TBO). The superheated particles were created by the failing motor brushes, and were being dispersed by the motor fans within the floor cavity.

Composite Rotor Blade Failure

An emergency medical helicopter was dispatched to an accident scene alongside an unpopulated stretch of roadway. The helicopter crew navigated by GPS, and adjacent to the accident scene the helicopter struck power lines and crashed. The wreckage scatter diagram showed the blades all were thrown in the same direction and within close proximity to each other, versus each scattering outwards in a different direction. DVI's helicopter maintenance and composites experts were retained to defend the rotor blade overhaul shop and investigate the cause of the rotor blade separation. They performed extensive

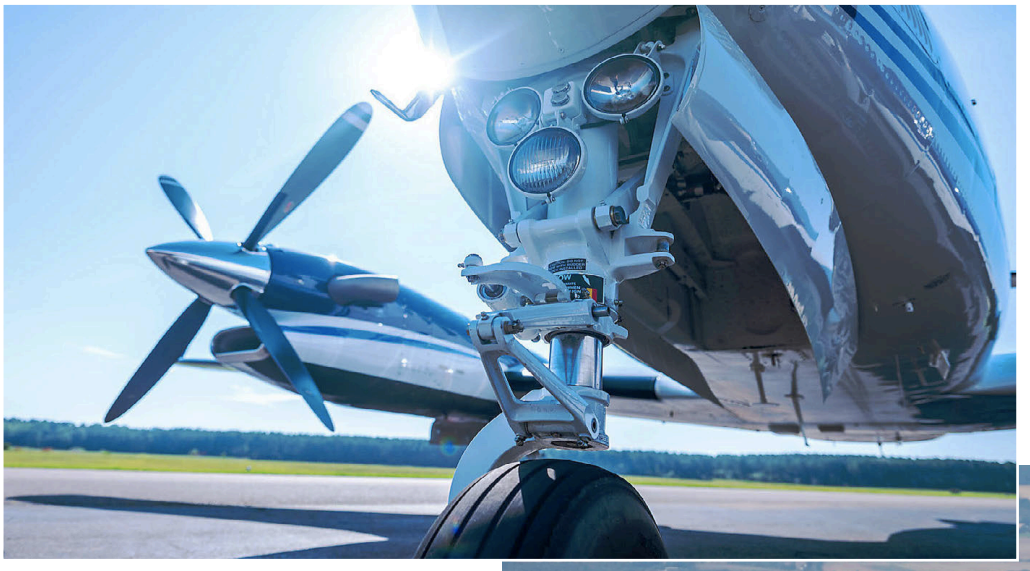
Top photo: Crashworthiness of Airframe Structure. A normal and routine oil change.

Above: Cracks in the Heater. The heater was never inspected or even disassembled by the NTSB.

testing to replicate and analyze the maintenance shop's procedure for replacing the leading edge abrasion strip, which was allegedly responsible for the composite rotor blade failure. All exemplar and subject testing, physical evidence, and wreckage scatter did in fact indicate that the composite blades struck the power lines, and that was indeed the actual cause of the accident.

Crashworthiness Of Airframe Structure

A pilot brought his aircraft in for a normal and routine oil change. Unfortunately, the maintenance shop neglected to safety wire the oil drain plug. Shortly after departure, the oil drain plug loosened, resulting in a sudden engine seizure. The pilot elected to make an off field emergency landing in a cornfield. Due to the height of the corn, and the selection of partial flaps, the aircraft stalled slightly above the soft mud, and decelerated quickly. While plowing into the soft mud, the engine separated from the structure and entered the cabin from beneath. DVI inspectors evaluated the forces the occupants experienced to determine if those forces were survivable. They reconstructed the



Above: Parts not Available. A twin-engine turbine aircraft was inbound for landing, but the pilot was unable to extend the main landing gear.

Right: Snagged on the Stop Bolt. A student pilot and certified flight instructor were practicing spins and spin recovery.

speeds and loads associated with the flight and plowing into the ground, the force of the impact with the engine structure, and measured the airframe, seat, and landing gear deformation.

Cracks in the Heater

A pilot had volunteered to fly a medical transportation flight in his twin engine aircraft. At, 10,000 feet, the last recollection of the pilot was seeing the sun set in the distance, and then seeing the VSI pegged downwards. One of the passengers recalled feeling three "bumps" and then an extreme pressure on her belt, and then a sudden release. Radar data and wreckage diagrams showed the aircraft came apart at around 10,000 feet, and miraculously the pilot and one of the passengers survived the fall, their impact cushioned by the forest below. DVI was retained by the maintenance shop that performed the last annual to determine the cause of the in-flight breakup. Inspectors were able to identify the correct sequence of the in-flight separation, and during the inspection discovered circumferential cracks in the Janitrol heater. The heater was never inspected or even disassembled by the NTSB. The cause of the accident was determined to most likely be carbon monoxide poisoning and temporary incapacitation of the pilot.

Parts not Available

A twin-engine turbine aircraft was inbound for landing, but the pilot was unable to extend the main landing gear. DVI's aircraft maintenance expert received the actuator for non-destructive testing and to facilitate a multi-party inspection. The part was X-rayed to document the subject evidence prior to disassembly. Fractured components were discovered in the actuator, and the fracture surfaces were examined under high power microscopes. DVI was able to research and trace the source of manufacture of the broken component, and found it was an approved part, and that the OEM part had not been available for over 15 years.

Snagged on the Stop Bolt

During a routine training flight a student pilot and certified flight instructor were practicing spins and spin recovery. Witnesses on the ground saw the aircraft spinning and impact the ground in a nose low attitude. In the wreckage, the rudder control horn was found to be caught on the rudder stop bolt. DVI was hired to determine if the rudder became jammed in flight or was a consequence of the impact with the ground. Inspectors fabricated a test rig using an actual aircraft fuselage, and performed extensive laboratory testing to determine what combination of factors and forces would be necessary for the rudder to snag on the stop bolt. ■

Not Pitch Perfect

Prop problems begin when a pressure relief valve stops sealing

ON **26 NOVEMBER 2020**, the Calm Air International ATR 42-300 aircraft (registration C-FAFS, serial number 298) was conducting flight CAV464 under instrument flight rules from Rankin Inlet, Nunavut, to Naujaat, Nunavut, with 3 crew members on board. While on descent, the crew observed abnormally low propeller rpm indications on the left engine. At 1326 Central Standard Time, shortly after touchdown on Runway 34 at Naujaat Airport, directional control was lost and the aircraft experienced a runway side excursion on the east side of the runway. The aircraft came to rest approximately 108 feet from the runway edge. The captain received serious injuries. The aircraft sustained substantial damage.

HISTORY OF THE FLIGHT

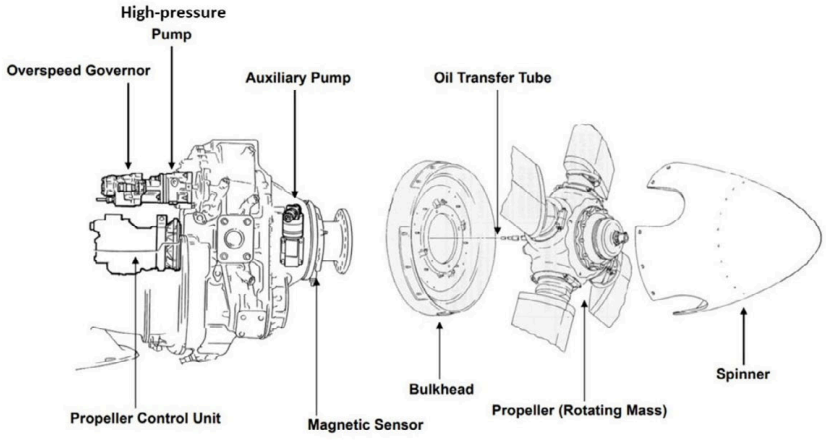
On 26 November 2020, the flight crew reported for duty at Rankin Inlet Airport (CYRT), Nunavut, at 0745. Before departing on the occurrence flight, they conducted a cargo flight to Baker Lake Airport (CYBK), Nunavut, in another ATR 42 aircraft and returned to CYRT.

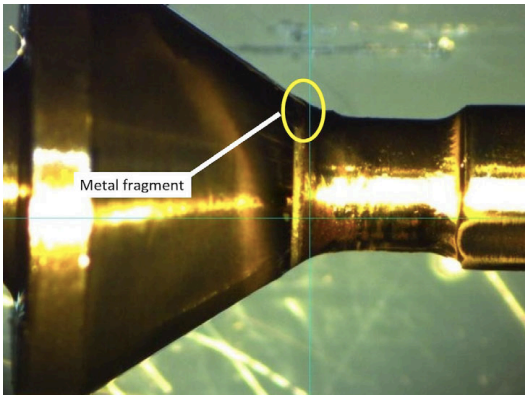
When the flight crew boarded the ATR 42-300 aircraft (registration C-FAFS, serial number 298) to conduct the occurrence flight, Calm Air flight CAV464, they noted, as part of their initial interior aircraft checks, that the left and right propeller feather solenoid circuit breakers were out and not collared. They called the maintenance supervisor, who informed them that the breakers had been pulled as part of a routine maintenance task that had been carried out the night before. At the request of the maintenance supervisor, the flight crew then reset the breakers as instructed.

At 1217, the occurrence aircraft departed CYRT destined for Naujaat Airport (CYUT), Nunavut. On board were 2 pilots and a flight attendant, as well as 3539 pounds of cargo. For this instrument flight rules (IFR) flight, 1272 L of Jet A fuel had been uploaded for a total fuel load of 5150 pounds. The departure, climb-out, and cruise portions of the flight were uneventful.

At approximately 1321, while the aircraft was on descent into CYUT, the flight crew observed that the left propeller was operating at a lower rpm than normal, while engine parameters remained normal. They briefly discussed the situation and made various attempts to troubleshoot and identify the problem, but did not consult the Quick Reference Handbook (QRH). They were unable to identify a specific malfunction and did not take any further action.

The captain considered his options: returning to CYRT, shutting down the left engine, or both. However, there was a crosswind at CYRT and he did not want to land on a runway with compacted snow in a crosswind or initiate a long return flight to CYRT in arctic conditions, particularly with only 1 engine operating. The captain believed that the propeller indications were related to the maintenance task that had been performed prior to the flight and did not discuss

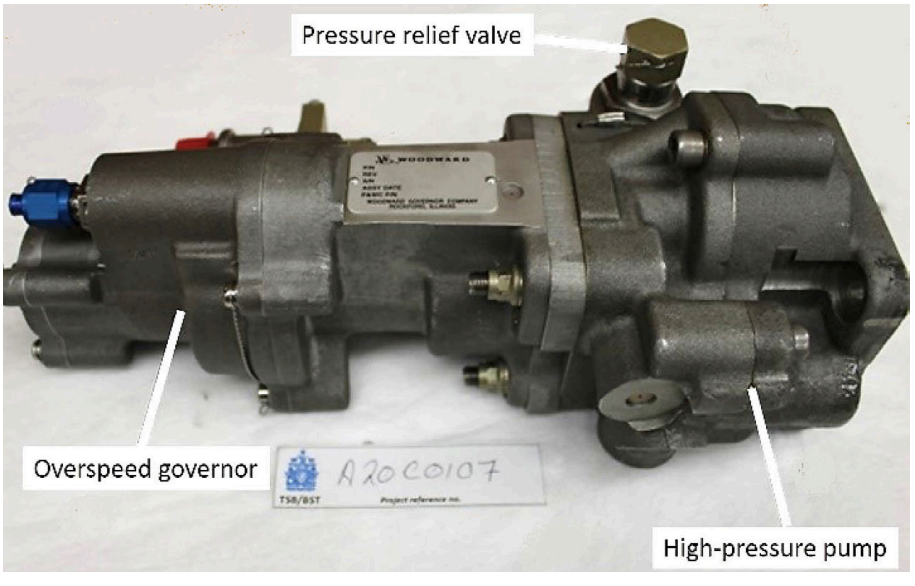




Above: Location of the metal fragment on the sealing surface on the high-pressure valve.

Opposite: Wreckage site. Above: The propeller system, with a propeller control unit, and the pitch change actuator, located within the rotating mass.

Below: Overspeed governor and high-pressure pump assembly.



the options with the first officer. The flight crew continued the approach and monitored the situation.

During the approach, the captain advanced the condition levers to see if he could achieve 100% propeller rpm. This was successful at first, but as engine torque was reduced on descent, the left propeller rpm started to decay. On short final, the left propeller rpm continued to decrease, and the aircraft was becoming noticeably more difficult to control. During the landing on Runway 34 at CYUT, the aircraft initially touched down 750 feet past the threshold and the pilot flying immediately selected reverse thrust on both power levers; however, only the right propeller went into reverse. Almost simultaneously with the selection of reverse thrust, only the "LO PITCH" light for the No. 2 engine illuminated, which went unnoticed by the flight crew.

At 1326, shortly after touchdown, the aircraft swerved to the right. In an effort to prevent a loss of control, the captain attempted to use asymmetric thrust and nose wheel steering. Although directional control was maintained momentarily for approximately 40 feet, lateral control was lost and the aircraft exited the right side of the runway in a northeasterly direction.

The aircraft travelled about 500 feet through the snow adjacent to the runway before coming to rest. At some point during the runway excursion, the captain's safety belt released, and his head struck the forward cockpit area. The aircraft came to a stop approximately 108 feet from the edge of the runway, at which time the flight crew shut down the engines with the fire handles because the condition levers were jammed. The captain received serious injuries and the 2 other crew members received minor injuries. The aircraft was substantially damaged. The emergency locator transmitter did not activate.

INJURIES TO PERSONS

The 3 crew members on board the aircraft were injured. The captain was seriously injured. He was examined at the Repulse Bay Health Centre and was later transported to Winnipeg, Manitoba, for further examination. It was determined that he had received serious head injuries. The 2 other crew members sustained minor injuries.

DAMAGE TO AIRCRAFT

After the aircraft had departed the maintained surface of the runway, it travelled through a windrow of compacted snow, then crossed through a shallow ditch and continued over rough terrain. During the runway excursion, the aircraft sus-

tained damage to the forward fuselage belly area. Additionally, the nose gear collapsed, both main landing gear assemblies were damaged, and the left main landing gear was almost completely severed from its attachment points.

AIRCRAFT INFORMATION

The ATR 42-300 is a pressurized twin-engine turboprop manufactured by Avions de Transport Régional (ATR) and type certified in the transport category. The occurrence aircraft was manufactured in 1993, and acquired by Calm Air in 2013. It was configured as a cargo/passenger combi aircraft. The forward area of the cabin was a cargo compartment with restraints and was separated from the rear passenger area by a bulkhead. The rear area, aft of the bulkhead, had seats to accommodate 22 passengers plus 2 flight attendants.

PROPELLER SYSTEM

The ATR 42-300 is powered by 2 Pratt & Whitney Canada PW121 turbo prop engines driving 2 Collins Aerospace (formerly Hamilton Sundstrand) Model 14SF-5 propellers. The 14SF propeller is made of metal and composite materials. It is a constant-speed, fully feathering, and reversible propeller. Propeller rpm (Np) and engine rpm (Nh) are controlled hydromechanically via power and condition levers in the cockpit. The mechanical movement of the power and condition levers direct the propeller control unit (PCU) and hydromechanical unit (HMU) to regulate propeller rpm.

The propeller is controlled by the PCU, which uses high-pressure engine oil to control the blade angle. Engine oil pressure is increased by a high-pressure pump mounted on the propeller reduction gearbox. There are 3 modes of propeller governing.

Fuel-governing mode: On the ground and at low aircraft speed, the HMU and electronic engine control maintain the propeller rpm at 70.8% by regulating fuel to the engine.

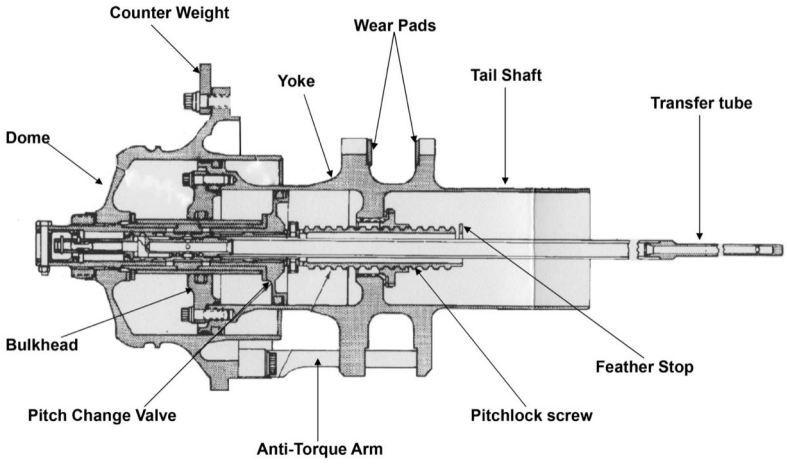
Transition mode: The propeller rpm (Np) is within 71% to 77%. Forward movement of the power lever (beyond the flight idle gate) adds more fuel, and the Np increases to 77%, where the condition lever position can start to control Np.

Propeller-governing mode: The Np is greater than 77% and the power levers are beyond the flight idle gate. Propeller speed is controlled by the PCU and input from the condition lever.

The propeller incorporates several safety devices, one of which is a pitch-lock mechanism. The pitch-lock mechanism is located inside the pitch change actuator. The mechanism locks the blade pitch and prevents propeller overspeed in the event that oil pressure to the PCU is lost. If oil pressure is lost while the propeller is in a positive blade angle, centrifugal and aerodynamic forces will attempt to drive the propeller blades to a flat pitch (approximately 0°). If this were to happen, the propeller would overspeed and produce high drag.

The pitch lock is engaged when the pitch-lock screw makes contact with the pitch-change valve on the bulkhead. The pitch of the pitch-lock screw thread combined with the friction between the pitch-lock screw and pitch-change valve is such that the acme thread of the pitch-lock screw cannot be back driven. This pitch-lock feature limits overspeed to approximately 2% at any positive blade angle as long as the operating condition and engine power do not change. If the pitch-lock is engaged, the flight crew cannot achieve reverse thrust.

When the power levers are in the ground-idle range and the aircraft is on the ground, there are ''LO PITCH" lights that illuminate when propeller blade angles are lower than the normal flight idle blade angle. These lights will not illuminate if the propellers are in a pitch-lock condition and are in the normal flight blade angle range. Other than subtle cues, there is no caution or warning light in the cockpit to indicate that the pitch lock is engaged; there is no pitch lock warning on the crew alerting panel (CAP) or on the master warning system.



Left: Pitch-change actuator showing pitch lock.

Above: Propeller rpm indicator, with digital counter, test push-button, and pointer labelled.

PROPELLER MAINTENANCE

The Collins Aerospace 14SF-5 propellers installed on Calm Air's ATR 42 aircraft are maintained in accordance with the Airworthiness Limitations section of the Hamilton Sundstrand Maintenance Manual, which states the major inspection intervals for various parts of the propeller. The inspection interval for the blade and pin assemblies, as well as the propeller hub (within which the pitch change actuator is mounted) is 10 500 flight hours or 7 years from the date of installation. The inspection interval for the propeller outer and inner bearing races and the actuator assembly is 10 500 flight hours.

In addition, a critical part inspection (CPI) is required for the actuator assembly, oil transfer tube and retainer, and PCU. The CPI interval for the actuator assembly is 10 500 flight hours. The interval for the initial inspection of the oil transfer tube and retainer and the PCU is 6000 flight hours or 3 years. The CPI must be repeated at intervals of 10 500 flight hours. These CPIs satisfy the requirements of the U.S. Federal Aviation Administration's Airworthiness Directive (AD) 96-25-20 as an alternate method of compliance.

A review of Calm Air's maintenance records indicated that the left propeller's components had been inspected in accordance with AD 96-25-20 on 18 November 2018 and were installed on the occurrence aircraft on 11 November 2019. The CPI had not revealed any defects that may have caused the propeller components to malfunction.

On 23 January 2002, the French Direction générale de l'aviation civile issued AD 2002-070-091(B) related to the pressure relief valve. The investigation determined that all inspections mentioned in this AD were either complied with or not applicable because of the part number.

There have been 4 other occurrences involving ATR 42 series aircraft in which flight crews did not identify pitch-locked propellers that resulted in control difficulties and runway excursions when reverse thrust was selecte. On 15 May 2002, the French Direction générale de l'aviation civile issued Airworthiness Directive 2002-070-090(B) R1 to address the issue.

COCKPIT ENGINE AND PROPELLER INDICATIONS

The engine and propeller indications in ATR 42 series aircraft are displayed in both analogue and digital formats. The dials indicate:

Engine torque in %
Propeller rpm in %
Engine rpm (Nh) in %
Engine oil pressure in psi (note: not propeller oil pressure)
Engine oil temperature in °C

The normal rpm range (between 70.8% and 100%) is indicated by a green arc on the gauge.

PROPELLER PITCH ANALYSIS

An analysis of the FDR revealed that the left propeller had entered a pitch-lock condition at the same time the flight crew observed the unstable propeller indication. The propeller pitch had locked at an approximate blade angle of 22.5°.

A tear-down inspection of the left PCU revealed that it did not meet certification criteria and was slow to function at normal operating temperatures. More detailed component testing of the propeller's high-pressure oil pump revealed that the pump's pressure relief valve had failed and was not allowing adequate oil pressure to build up in the system.

A metal fragment composed of a low-grade iron substance was discovered stuck to the sealing surface of the pump's pressure relief valve, which prevented the pressure relief valve from sealing. The origin of the metal fragment could not be determined; however, the composition of the metal contaminant was not consistent with any parts tested. Given the size of

the metal fragment, it should have been trapped by the engine oil filter.

The propeller entered the pitch-lock condition because of the degraded pressure output from the high-pressure pump. The tear-down inspection did not reveal any other pre-existing defects or anomalies that could have caused the left propeller to enter a pitch locked condition.

PROPELLER CONTROL UNIT FAILURE

The tear-down inspection of the left propeller control unit (PCU) revealed that it did not meet certification criteria and was slow to function at normal operating temperatures. Testing of the propeller's high-pressure oil pump revealed that its pressure relief valve was not allowing adequate oil pressure to build up in the system.

Metal contamination from an undetermined source was found in the high-pressure pump's pressure relief valve and was preventing the valve from sealing. The impeded seal decreased the pressure output from the high-pressure pump, and decreased the ability of the PCU to control the propeller pitch.

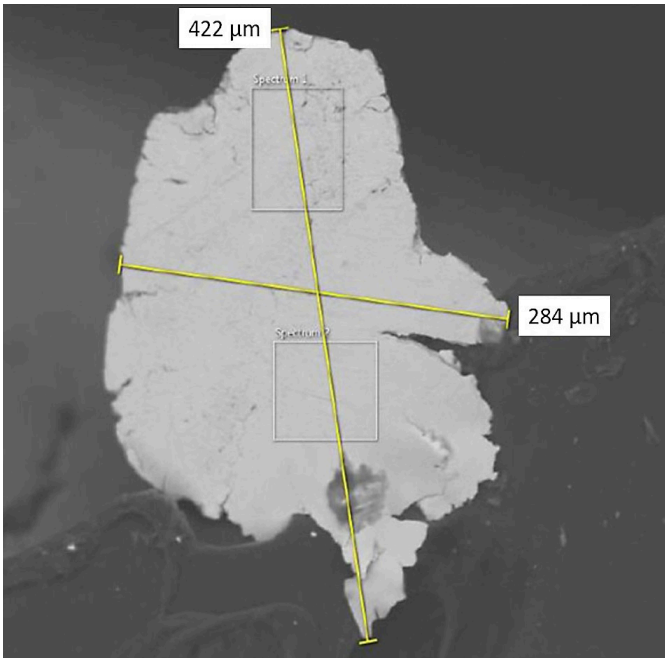
This decreased pressure output occurred during the cruise portion of the occurrence flight, around the same time the flight crew observed the unstable propeller indication. When the decreased pressure output occurred, in order to prevent the aerodynamic and centrifugal pressure from driving the propeller blades into fine pitch (and cause an overspeed condition), the propeller pitch-lock mechanism activated and locked the propeller blades in approximately 22.5° of pitch. This pitch-lock condition was, however, unknown to the flight crew.

FINDING AS TO CAUSES AND CONTRIBUTING FACTORS

A contaminant inside the left propeller's high-pressure pump caused its pressure relief valve to fail. As a result, the propeller entered a pitch-lock condition and remained in that condition until the aircraft landed.

The Calm Air Standard Operating Procedures (SOPs) require the pilot monitoring to make a call if both LO PITCH lights illuminate on touchdown and specify that reverse thrust is not permitted if only 1 light illuminates. There is no requirement for a standard call in the SOPs or the ATR 42 Aircraft Flight Manual (AFM) for the non-illumination of a low pitch light during landing. However, the AFM, the QRH, and the Flight Crew Operations Manual (FCOM) all state that if both LO PITCH lights do not illuminate after landing, reverse thrust must not be selected because the pitch change mechanism is probably locked at a positive blade angle.

On touchdown, 750 feet past the threshold, the pilot flying immediately selected reverse thrust, possibly due to the relatively short runway length; however, only the right propeller



The metal fragment, retrieved from the sealing surface, was composed of a low-grade iron substance not common to the parts tested.

went into reverse. Almost simultaneously with the selection of reverse thrust, only the "LO PITCH" light for the No. 2 engine illuminated. The pilot monitoring did not have the time to identify the status of the LO PITCH lights and to make the "TWO LOW PITCH" callout before reverse was selected. The flight crew was unaware that the left propeller was in a pitch-lock condition and that reverse thrust was unavailable on the left side.

ADDITIONAL FINDINGS AS TO CAUSES AND CONTRIBUTING FACTORS

Immediately on touchdown, reverse thrust was selected by the pilot flying without confirmation that both LO PITCH lights had illuminated. With the left propeller in a pitch-lock condition, the selection of reverse thrust resulted in the aircraft entering an asymmetric thrust state.

Due to the asymmetric thrust, directional control of the aircraft could not be maintained. As a result the aircraft exited the landing surface of the runway, travelled across rough terrain adjacent to the runway, and was substantially damaged.

FINDINGS AS TO RISK

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences. If flight crews do not assess abnormal situations as a team, there is a risk that they will not identify the nature of the abnormal situation and determine the most appropriate action to take. If the layout and design of a Quick Reference Handbook make it difficult for flight crews to find a procedure to address a malfunction, they may not take the appropriate actions quickly or efficiently, which may lead to an unsafe aircraft state.

SAFETY ACTION TAKEN

On 09 December 2020, the operator issued Flight Operations Bulletin 2020-07, which describes a condition known as "pitch lock." It further describes: possible causes for this condition; how to identify it; and what action to take if this condition is suspected.

In February 2021, the operator introduced to its ATR 42 recurrent simulator training scenarios in which the propeller enters a pitch-lock condition. ■

(These were excerpts from the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 19 October 2022. It was officially released on 01 November 2022.)

Aviation Services

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Five Strange Loads

The majority of air cargo is "normal," but occasional consignments are not. Here, the experts at Artemis Aerospace look at some of the weirder items to have been transported by air.

YODA FROM STAR WARS

FINDING the perfect Christmas gift can be fraught with difficulties. However, one generous individual, not to be outdone sourcing the gift of their recipient's dreams, arranged for a Lego store in Tennessee to fly a pre-built Lego Star Wars Yoda statue across the US. This isn't the first time that Lego creations have been shipped – master builders at Lego regularly fly their creations to destinations all over the world.

PIECES FROM THE TITANIC

The infamous and ill-fated ship is known worldwide for sinking in the Atlantic after hitting an iceberg on its maiden voyage from Southampton to New York. After many years trying to locate the wreck, the site was discovered in 1985 with portions of its hull and other relics being brought to the surface in 1987 – much of which can now be viewed as part of a travelling exhibition. These precious artefacts are regularly flown between museums and displays around the world, helping to keep the story of the Titanic and its passengers alive.

THE MUSICAL EVITA

When this award-winning musical about Evita Perón's life went on tour to the UAE, a Boeing 777 transported the entire set and costumes from Schiphol in Amsterdam to the Middle East. According to the handlers who loaded the aircraft, due to the size and shape of the pieces, it proved to be quite a challenge to fit everything into a single plane.

HUMAN ORGANS

In 2020, there was a total of 129,681 life-saving human organs transplanted worldwide. These include kidneys, lungs, eyeballs, corneas, hearts and bone marrow. Time is of the essence for this precious cargo with some organs only remaining viable for transplant outside the body for as little as four hours. It is estimated that as many as 10 organs for transplant are carried on aircraft every day.

POISONOUS SNAKES

The action film Snakes on a Plane might seem like a ludicrous and unlikely scenario, but venomous snakes are shipped daily from airports all over the world. However, unlike the film's plot, snakes are unlikely to break free and roam the cabin aisles terrifying passengers. Proper containment of these creatures requires them to be securely placed inside two knotted pillowcases that are then put inside a Styrofoam container, all of which is eventually packed firmly into a wooden box that is secured to the floor – phew! ■

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