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AirMaintenance UPDATE

The Magazine for Aircraft Maintenance Professionals

Transport Canada Approved for R/T

AME History Part 3

PAMA and AME news

2021 Recurrent Training Exam

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Thoughts on Piccard, his balloon, and Recurrent Training

PHOTO: WIKIPEDIA

TIME FLIES — and so did **Auguste Piccard**. It was 90 years ago on May 27, 1931 that the Swiss balloonist and his co-pilot **Paul Kipfer** became the first humans to enter the stratosphere. Hunkered down in a pressurized cabin invented by Piccard, their giant gas balloon flew to a height of 15,781 metres above the earth, marking a major turning point for both aviation and space travel and in the process yet again begging the question: who has more fun than people?

Launching from Augsburg, Bavaria, Piccard and Kipfer were able to gather data on both the upper atmosphere and cosmic rays, while also observing the curvature of the earth, almost certainly a world-first. Their adventure during aviation's pioneering era probably did not require much certification, licensing, or bureaucratic red tape—give or take some minor hassle with German authorities. Like so many "Magnificent Men in their Flying Machines" of that time, they simply had an idea and went for it.

We mention the anniversary of Piccard's flight this issue as a counterpoint to Roger Beebe's ongoing series about the history of the profession called Aviation Maintenance Engineer and how it evolved from a time when the term didn't even exist and most of the early practitioners were self-taught and/or acquired knowledge shared among the small peer group of the time. The earliest aircraft engineers were scarcely recognized as such and learned their craft through mainly trial and error before the requirements of mandatory testing and training and the concept of Recurrent Training. Speaking of which, it is once again time for our annual Transport Canada-approved RT exam, contained within this issue. Best of luck with it! ■

— John Campbell, Editor

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Upcoming Events

NBAA: CONVENTION DEMAND POINTS TO A STRONG 2021 SHOW

The National Business Aviation Association has begun preparations for its 2021 Business Aviation Convention & Exhibition scheduled for October 12-14 in Las Vegas, Nevada, and organizers report the demand for participation is exceptionally strong among exhibitors and attendees alike. The exhibit floor is nearly sold out, says the NBAA, with 90 percent of the planned space booked. The exhibitor lineup, including dozens of new forward-looking companies, will be showcased in the Las Vegas Convention Center's brand-new, state-of-the art West Hall.

A recent survey of NBAA-BACE attendees demonstrates a strong appetite for a return to face-to-face networking, with 88 percent expecting to attend live events in the autumn timeframe, a number up appreciably from an identical attendee survey earlier this year.

The association's location for hosting the show in the convention center's West hall has been met with enthusiastic response. The new facility features 600,000 square feet of contiguous exhibit space, 80 new meeting rooms and an expansive, 14,000-square-foot outdoor terrace for receptions.

"NBAA-BACE 2021 is shaping up to be a special event," said association President and CEO Ed Bolen. "Although a small number of companies are not participating in trade shows this year, we're thrilled that nearly all the leading companies in business aviation will be at NBAA-BACE, some in a very big way."

The association also noted other new plans to enhance the attendee experience this year including an expanded floor footprint for advanced air mobility technology, a heightened week-long focus on business aviation sustainability and an expanded program featuring sought-after thought leaders who are shaping the industry's future.

"NBAA-BACE will be a celebration of innovation, technology, sustainability, workforce development – essentially all-things business aviation," said Bolen. "It will be a truly transformative week, as we come together to unite with each other and ignite the imagination."

nbaa.org/bace

The following is a list of Canadian airshow events tentatively scheduled in coming months. If you plan to attend please remember that COVID-19 will ultimately determine whether or not the various events can stay on track.

June 26, 2021
Spectacle Aerien International de Bagotville 2021
CFB Bagotville, Quebec
www.rcaf-arc.forces.gc.ca

July 1, 2021
Canada Day Canadian Snowbirds
Ottawa, Ontario
www.rcaf-arc.forces.gc.ca

July 17, 2021
Boundary Bay Airshow
Delta, British Columbia
www.rcaf-arc.forces.gc.ca

July 18, 2021
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White Rock, British Columbia
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July 21, 2021
Northwest Regional Airshow
Terrace, British Columbia
www.rcaf-arc.forces.gc.ca

August 6-8, 2021
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With four different jaw-size widths, the new WV1700 Series vises from **Snap-on Industrial** are built from 60,000 PSI ductile iron castings and backed by a lifetime warranty. A fully sealed one-piece spindle-nut assembly keeps lubricants in and contaminants out for smooth operation. The precision-machined slide bar eliminates side-play movement regardless of the opened distance. The vise's serrated pipe jaws are made from machined steel and come with black phosphate coating for extended life. The 360-degtee swivel base has double lockdowns for easy and secure access while in use. **www.b2b.snapon.com**

Composite prop offers airspeed increase

Hartzell's Navigator three-blade composite scimitar propeller is now approved for thousands of **Beechcraft Bonanza** single-engine airplanes. The new STC applies to Bonanza models including most 35-C33A, E33A, E33C, F33A, F33C, S35, V35, V35A, V35B, 36 and A36 aircraft. Available as part of Hartzell Propeller's Top Prop program, the Navigator's Advanced Structural Composite (ASC-II) lightweight blade technology results in an increase in true airspeed of three to seven KTAS. The ASC-II blades reduce airframe vibration, which results in a smoother flight. **www.hartzellprop.com**

Hydraulic seal won't leak at ultra-cold temps

Greene Tweed has released its new EPM 953 elastomer for phosphate ester hydraulic systems in aerospace applications. Developed for its ultra-low-temperature performance and compatibility with phosphate ester hydraulic fluids, EPM 953 outperforms existing EP elastomers and maintains an excellent seal at temperatures as low as -85F (-65C).
Suitable for static and dynamic seals in hydraulic actuation systems, the EPM 953 delivers improved elasticity at ultra-low-temperatures. The new proprietary elastomer material ensures high durability and little to no hydraulic fluid leakage over the lifetime of an aircraft. **www.gtweed.com**

Blanket keeps blades out of the oven

With their heating blanket solutions, **Veelo Technologies** aims to help composite rotor blade manufacturers and repair facilities keep blades out of the oven. Veelo's heating blankets can be tailored for use in debulking and bonding applications and can be used in-situ, eliminating the need to transport long and bulky rotor blades to an oven. Eliminating that transportation step helps improve build and repair rates while reducing scrap. These blankets are highly drapable and provide uniform heating coverage across the large and geometrically complex surface areas found on rotor blades. **www.veelotech.com**

Fuel app verifies results on the spot

Conidia Bioscience has launched an upgraded mobile digital verification tool called FUELSTAT which allows operators to verify fuel test results and create a report that can be immediately printed or emailed. The user simply lines up the test kit with the outline provided on screen. When aligned, the outline will turn green and the app will verify the results, giving a clear and instant indication of levels of microbial contamination within the fuel using a traffic light system. An additional alert will be given if the results are close to a threshold. **www.conidia.com**

Peregine STC brings brushless blower

Peregrine received FAA approval for improved reliability of the **Hawker 4000 cooling blowers.** Applicable to the entire fleet of the Hawker 4000, the installation data and Supplemental Type Certificates are now available from Peregrine. The STC and Parts Manufacturing Approval-qualified installation hardware improves dispatch reliability and reduces maintenance actions caused by annunciated failures of the aft compartment heat exchange blower. Used during ground operations in higher ambient temperatures, the Peregrine STC incorporates an AMETEK brushless blower exhibiting significantly higher reliability and greater assurance of eliminating hot spots in this compartment. **www.peregrine.aero**

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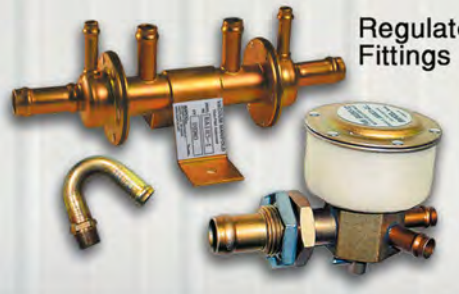

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ENGINE VIBRATION COURSE EARNS CREDITS

MTI Instruments reports that its training course on the PBS-4100+ engine vibration measurement and balancing system is now credit-eligible under the Federal Aviation Administration's William (Bill) O'Brien Aviation Maintenance Technician Awards Program. With the new credit designation the course can earn an eligible individual up to 16 hours of credit towards AMT Awards issued through the FAA Safety Team continuous training program. MTI Instruments products are designed to swiftly pinpoint engine vibration problems and eliminate avoidable engine removals. The PBS-4100+ course is offered throughout the calendar year.

TEN-YEAR BOMBARDIER INSPECTION NOW DONE

MRO operator Flying Colours says it has now completed a 10-year heavy maintenance inspection for a Bombardier Global XRS aircraft on behalf of a UK-based customer. In addition to the airframe inspection and maintenance strip down, the aircraft underwent additional upgrades including the equipping of Ka-band connectivity and ADS-B Out installation. The Honeywell JetWave Ka-band system necessitated hardware installation of a tail-mounted antenna, cabin router, modem and associated wiring to support global high-speed connectivity. A further three Bombardier Global aircraft are scheduled for 10-year heavy checks over the next six months at Flying Colours North America facilities.

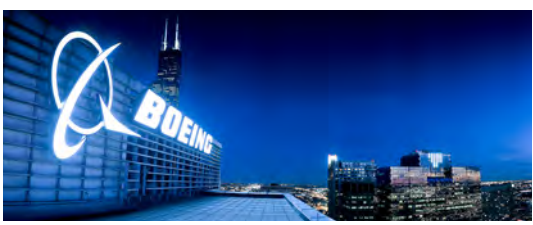
SEEING THROUGH THE SMOKE

Columbia Helicopters and Boeing-owned Aurora Flight Sciences will jointly explore the design of degraded visual environment (DVE) flight capability for firefighting helicopters.

Since aerial firefighting began, nothing currently exists to enable pilots to fly safely in DVEs caused by thick and persistent smoke during the day. Columbia and Aurora aim to overcome these limitations with a new flight system that integrates multiple aircraft-mounted sensor technologies that enhance situational awareness and deliver a real-time, clear, synthetically-adapted image to the pilot.

HARTZELL KEEPS SPINNING DURING COVID

COVID-19 has not brought all business to a halt. The Hartzell group of companies reports it has launched over a dozen new products during the past year of pandemic and will continue to make investments in products and new technologies. "On the Hartzell Propeller side, recent new product launches include STCs for the Odyssey, a four-blade composite scimitar prop for the Cirrus SR-22/22T, the Navigator, a three-blade composite scimitar prop for the Bonanza fleet, and the Voyager, a three-blade aluminum prop for the Cessna 180, 182, 185, and 206 aircraft," said Hartzell Propeller President JJ Frigge.



BOEING NOW LAGS BEHIND AIRBUS

Boeing is one of the biggest companies in the world, but the airline giant has had a tumultuous last couple of years. Even before 2020's Coronavirus pandemic, the company was already experiencing sharp declines in various metrics due to a major global controversy around its 737 MAX 8 aircraft. According to data from Buyshares.co.za, Boeing's revenue of $58.16 billion in 2020 was a 42.5 percent decrease from 2018's record-high revenue of over $101 billion. Moreover, Boeing has now fallen behind its chief rival—in 2020 Airbus delivered almost 400 more aircraft than Boeing, amounting to 566 and 157 respectively.

RUSSIAN GRANDMA STILL GOING STRONG

A 99-year-old Russian World War II veteran, Maria Koltakova, recently took part in a training session on board a Sukhoi Su-34 flight simulator at Voronezh Malshevo air base, south of Moscow. For 90 minutes, Koltakova acted

as a navigator to Russian Air Force pilot Andrei Dyachenko. They performed a series of turns, loops, horizontal barrels, and jointly refueled in the air, according to a Russian military news release. During the war Koltakova served in a Red Army ambulance battalion, participated in the battle of Kursk, and is listed in the Russian Book of Records 14 times.

THE PEARL AND THE FALCON

Rolls-Royce unveiled the the third member of its Pearl engine family during the month of May, an engine intended to power Dassault's new Falcon 10X, which was revealed during a digital ceremony at Le Bourget airport in Paris. The Pearl 10X features the Advance2 core and produces a factory-spec 18,000 pounds of thrust. Rolls-Royce says the Pearl 10X offers five percent higher efficiency while delivering outstanding low noise and emissions performance. The result is an engine that will enable operators to have premium airport accessibility and fly long ranges nearly as fast as the speed of sound.

QUEBEC SUPPORTS GREEN AIRCRAFT OF TOMORROW

In early spring the government of Quebec announced it will support the Coalition for Greener Aircraft, enabling funding of the "Aircraft of Tomorrow" program and

the development and demonstration of new green technology in the province. Within that program, Bell is part of a consortium leading the project "Aircraft for the digital and green mobility of tomorrow" where it will develop advanced propulsion systems to support future technology. Bell's assembly centre in Mirabel, Quebec is home to many vertical lift innovations, including where Bell's Autonomous Pod Transport and Electrically Distributed Anti-Torque first took flight. ■

The Eight Best ideas for Future Flights

Canada was a winner as Crystal Cabin Award trophies were handed out for 2021. The annual event was digital this year but still offered a glimpse at the systems and features you may have to deal with going forward.

Above: Airbus presented its Airspace Cabin Vision 2030, an extension of the "Airspace" concept, digitally tailoring the cabin to passenger needs.

Top right: Alice's innovative cabin concept with a fishbone seating layout, created by Almadesign of Portugal, won a Crystal Cabin Award trophy.

Bottom right: AirGo Design's Galaxy Flatbed for A321.

THE 14TH ANNUAL CRYSTAL CABIN AWARDS were presented in Hamburg during the month of March with Canada's $e_2$ip technologies joining international firms like Airbus as winners of the globally respected prize for cabin innovations and on-board products. Normally, the leading prize for the international aircraft cabin industry brings the Who's Who of the industry together for a gala event during the Aircraft Interiors Expo trade fair in Hamburg. The ceremony for the eight winners of the 2021 trophies, however, was digital, streamed live around the world.

With a broad spectrum of innovation and engagement with current challenges, the winners of the 14th Crystal Cabin Awards make it clear that the aviation industry is not standing still despite the current crisis. As the presentation of the coveted white trophies took place digitally across the world's many timezones, the finalists of the eight categories learned of their victories on TV and were then brought into the studio directly by livestream. High-ranking industry representatives honoured the 24 finalists and their concepts in their addresses as they presented the prizes.

The future of the cabin was on display in the "Cabin Concepts" category. Alice, the first purely electric commuter


PULL
design by almadesign

Left: Diehl Aviation's Greywater Reuse Unit makes it possible to re-use water from the handbasin to flush the lavatory.

Below: $e_2$ip technologies presented a panel based on In-Mold Electronics, surface-printed electrical circuitry that saves on complex, heavy cabin electronics.

jet, from Israeli company Eviation Aircraft, made its debut at the Paris Airshow in 2019. It will carry nine passengers over a distance of up to 1,000 kilometres. The plane's innovative cabin concept with a fishbone seating layout, created by Almadesign of Portugal, won a Crystal Cabin Award trophy, presented by Polly Magraw, Event Director at Reed Exhibitions, organizer of the Aircraft Interiors Expo.

Another foretaste of flight in the world of tomorrow is provided by the winner in the "Visionary Concepts" category. Airbus presented its Airspace Cabin Vision 2030, an extension of the "Airspace" concept, digitally tailoring the cabin to passenger needs and expanding the on-board experience with flexible seating and lounge configurations, for example a gaming or family compartment. The trophy was presented by jury member Paul Sweeney from Sydney, Program Manager Aircraft Design and Projects with Qantas Airways.

The "Material and Components" category approaches the demands of our time from very different angles. Together with the National Research Council of Canada, the Canadian victor, $e_2$ip technologies presented a panel based on In-Mold Electronics (IME), surface-printed electrical circuitry that saves on complex, heavy cabin electronics. The IME control element can be seamlessly integrated in its environment, taking on a range of functions such as the positioning of the aircraft seat. Furthermore, the system is retrofittable making it suitable for a wide range of existing aircraft. This resource-friendly aspect won over the jury. The trophy was presented by Senator Michael Westhagemann, Hamburg's Minister for Economic Affairs & Innovation, who talked about the

SOPHY is a tiny module integrated in the catering trolley that provides the operator with information on the entire journey of the equipment, from maintenance and cleaning needs to load.

Above: JetBlue's Multi Screen Experience.

Below: The award-winning Modulair S economy seat concept from Safran Seats.

growing importance of aviation innovations in view of the current situation.

Proof that innovation is often a matter of detail but can transform air travel was provided by the finalists in the "Greener Cabin, Health, Safety and Environment." Frederic Dupont, Vice President Technical Sales and Customer Service at platinum sponsor Etihad, announced the deserving winner, Diehl Aviation. The company's Greywater Reuse Unit makes it possible to re-use water from the handbasin to flush the lavatory, rather than tipping precious drinking water down the drain. As a result, the aircraft has to carry less water reserves, making it significantly lighter. For a Boeing 787, this means savings of up to 550 tonnes of CO2 per year.

Above: Virgin Atlantic's Upper Class Loft.

Opposite right: University of Cincinnati presented its Coffee House Cabin, a long table for meetings, productive work and coffee breaks.

The industry is very hopeful that we will soon be able to travel freely again. And the award-winning Modulair S economy seat concept from Safran Seats is a boost to the sense of anticipation

in the "Passenger Comfort Hardware" category. Developed in cooperation with the French university ENCSi, the seat can be extended with various features, bringing creature comforts such as neck support or a tablet holder to "cattle class" passengers. Jury member and Vice President Product Innovation at Singapore Airlines, Yunghan Ng, joined the ceremony by livestream from a Singapore Airlines cabin model to present the trophy.

Just as passengers are becoming more and more digitally connected, so are cabin elements. French company Safran Cabin garnered its second prize for the evening in the "Cabin Systems" category with SOPHY. This tiny module is integrated in the catering trolley and provides the operator with information on the entire journey of the equipment, from maintenance and cleaning needs to load. Colette Doyle, editor at the Crystal Cabin Award's media partner, Aircraft Cabin Management, joined the ceremony from London to present the award.

The fact that passengers are increasingly using wireless headphones to enjoy on-board entertainment is a challenge for many airlines, because conventional Bluetooth connections fail when the demand in the cabin reaches a certain level. RAVE Bluetooth helps out here, promising uninterrupted transmission throughout the aircraft. This really excited jury member Corinne Streichert, Senior Manager for Inflight Entertainment and Connectivity at United Airlines, who presented the trophy in the "In-Flight Entertainment and Connectivity" — once again to Safran, this time to the Passenger Solutions division.

As every year, all finalists were required to present their entries to the international Crystal Cabin Award jury in a final round, but for the first time this was conducted virtually. For entrants in the "University" category this undoubtedly lent an "exam feeling" to the process. In the end, it was the University of Cincinnati that won the day, having already made it to the final in 2019. The coveted trophy was secured by the Coffee House Cabin, a long table for meetings, productive work and coffee breaks. Winner Alejandro Lozano Robledo developed the concept together with The Boeing Company and The Live Well Collaborative. Melissa Raudebaugh, General Manager Aircraft Experience at Delta Air Lines and chair of the jury, presented the virtual trophy from her company's head office in Atlanta.

In 2021, in view of the global Covid-19 pandemic and its impact on global air travel, there will be two special categories for the Crystal Cabin Award: "Clean & Safe Air Travel" and the "Judges' Choice Award." They are scheduled for presentation at the Aircraft Interiors Expo in Hamburg on August 31st. ■

AME History, Part 3: By Roger Beebe

Aircraft Maintenance Engineer Roger Beebe has compiled a history of the trade in Canada, from which we have taken excerpts and are presenting as a multi-part series. This issue, Beebe's focus is on the post-war years.

Time of Change

Any history of AMEs in Canada would not be complete without mentioning the AMEs working in the bush.

ANY HISTORY of AMEs in Canada would not be complete without mentioning the AMEs working in the bush. The bush definition covers all the outlying country of Canada north of the traditional settlement area. Aircraft and their attending AMEs opened up most of Canada. The only other mode of transport to compare with aircraft would be the canoe, which allowed first nations travelers and traders to travel all over Canada in summer.

AMEs had to camp out in the wilderness and jury rig machines to be able to conduct maintenance in the field. The bush lore they built up led to the development of industry practices still in use today. They obviously needed to learn how to live off the land. They had to make their tents and cabins as comfortable as possible under the circumstances. They needed to understand how to get water for drinking, and find fuel to cook and keep warm. Hunting and fishing were more than an enjoyment; they were a way to supplement their food source and improve their diet.

The only other mode of transport to compare with aircraft in bush country would be the canoe.

Left: The first aircraft were piston engine propeller driven varieties of military aircraft. The AME of that day generally had lots of piston engine experience from their Air Force and Navy time.

Above: Once the Second World War ended many large aircraft pilots and maintenance technicians were around to use their wartime experience to build Canada's airlines.

AMEs working in the field had to be very innovative. Many of their procedures were not in company maintenance manuals, repair schemes, etc. They had to jury rig engine hoists, jigs and make special tools to carry out their work. A good knowledge of metallurgy was needed together with an expert understanding of aircraft structures and engine design. Early AMEs working in the bush also needed to be expert welders and machinists. They had to be able to fabricate from local resources, mainly wood or metal they had carried along.

There are many excellent books available written by early bush pioneer AMEs who go into great detail on describing some incredible aircraft recoveries and maintenance exploits. Some of the stories revolve around the very difficult job of helicopter AMEs changing transmissions and engines in the forest with only homemade wooden tripods; engine changes on the shore, working in frigid water; float repairs quickly completed, but good enough to get one home.

Even back at home base things could be rudimentary; small cabins to live in and nose hangers to work in. Remember, in those days everything you needed had to be flown in, so rework or recycling was the way of life. Summer had its own set of problems, mainly insects and the diseases caused by them. Winter brought on the extreme challenges to humans and machines caused by the brutal cold weather.

Without AMEs who were prepared to spend a good portion of their lives in the bush, one cannot help but imagine that Canada's aviation story in the bush would not have been possible. One wonders what motivated them; money? Sometimes, as jobs at times were scarce. More probably the life of adventure appealed to those who liked freedom and working far from supervision, a chance to live off the land, and perhaps a pride in being self sufficient and getting things done.

Post War Air Carriers

The airline industry had its beginnings in the 1930s but it was the advances in aircraft, Air Traffic Control and transoceanic flying developed during the war that made it a later success. Once the Second World War ended many large aircraft pilots and maintenance technicians were around to use their wartime experience to build Canada's airlines. Trans Canada Airlines expanded rapidly as well as many others. The role of the AME was vital to this expansion. Many of them rose to positions of management in a rapidly changing airline world.

The first aircraft were piston engine propeller driven varieties of military aircraft. The AME of that day generally had lots of piston engine experience from their Air Force and Navy time. Piston engines were complicated machines and very dirty to work on. They also took a lot of time and manpower. The image of the AME as similar to an auto or farm mechanic came about because of the perception of the dirty work. This was mainly caused by the fact that early machinery used lots of grease, oil and heavy hardware. The oil and grease part also applied to early aircraft, hence the comparison to the more commonly known mechanics. Aircraft systems were starting to become more complex as electronics systems developed during the war came into use. The arrival of more and more electronics together with the use of jet engines in civil aviation airliners completely changed the AME world.

Until the early 1950s, piston engine powered aircraft like the DC-6 and the Constellation continued to be the mainstay of the airlines. These aircraft required the knowledge of piston engines and used the expertise gained by the wartime experience of AMEs working on Lancaster's, B-17's, DC-3's and other common types. This knowledge and experience was readily transferred to the post war airlines. The introduction of the jet powered airliner; the early 707, Comet, and DC-8, brought a requirement for a new body of knowledge. Of course jet engine theory was one of these new areas, but there was also the question of maintaining pressurized hulls and the new field of avionics.

The Great AME licence Debates and Changes

The 1950s was a time of great change for many AMEs and technicians. The training and experience many of the senior AMEs had was no longer so effective in maintaining the new jet aircraft. Nothing changed in a hurry, because many piston engine aircraft soldiered on for many years. In fact there are

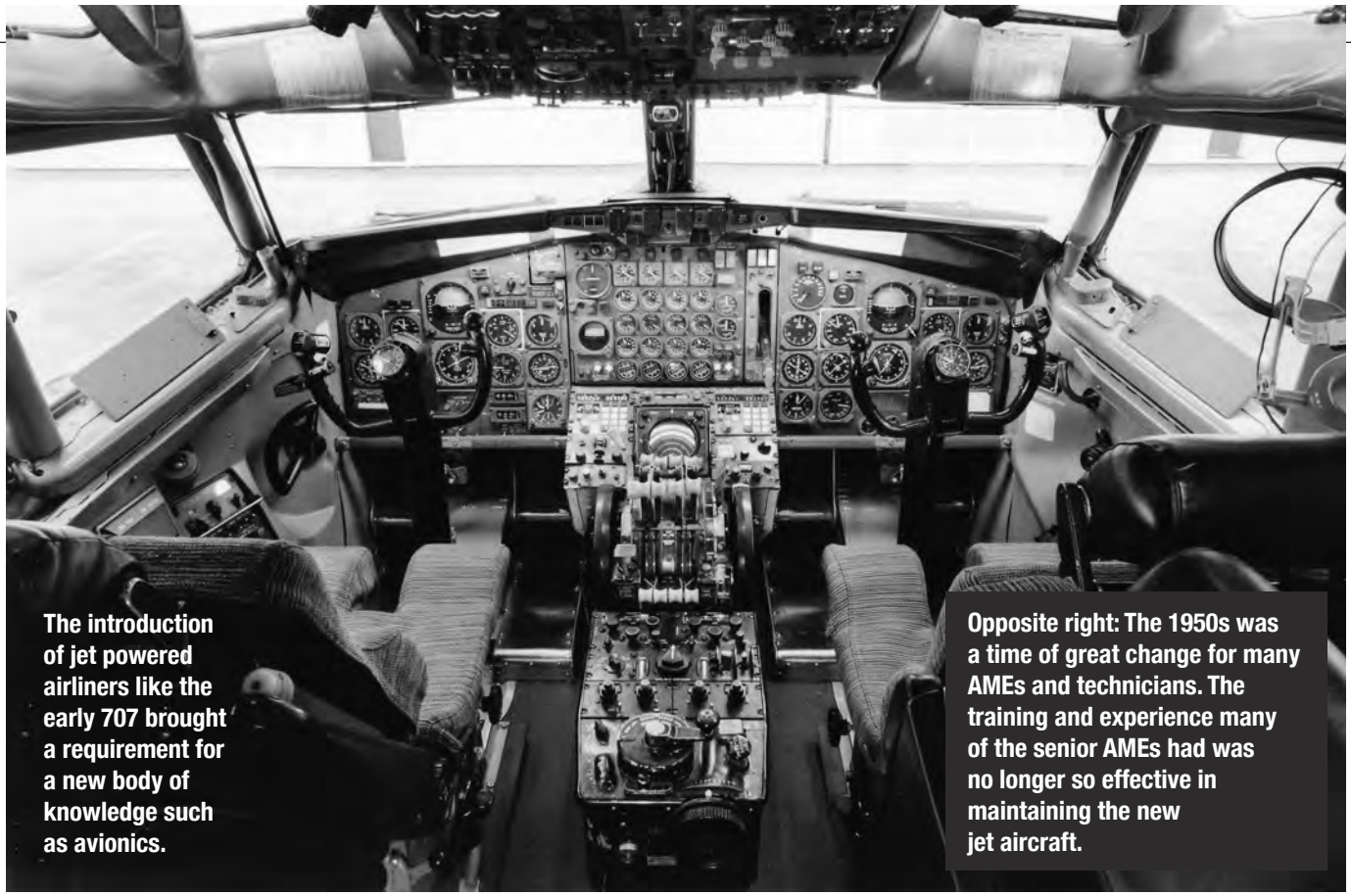
Opposite left: Most early helicopter technicians had their start in the military.

Above: Until the early 1950s, piston engine powered aircraft like the DC-6 and the Constellation continued to be the mainstay of the airlines.

still large piston engine aircraft in service today. The new emphasis though, was on the complex jet systems and on avionics. One of the issues I believe airline management had to face was that electronics education requires a good foundation in science and mathematics, which some of the older AMEs did not have. These led many organizations to create a new trade, avionics.

The world did not end for the classically trained AMEs. They were the senior people and remained so for years. Their experience in managing and leading technicians served them and the industry well for many years. However, the workload dramatically shifted from crews heavy on engine fitters and riggers, to crews that included many more specialists like avionics. The shops continued to be staffed by people who had narrower but more in depth training in such fields as instruments, electrical equipment, etc. This continues today. So as the composition of the crews changed, so did the work.

On the flight line, more systems troubleshooting became the norm. Some trades who had been considered pampered by not being required to tow or fuel aircraft now had to join in these tasks with the others. The line between job functions blurred. One major negative that affected AME Category A,



The introduction of jet powered airliners like the early 707 brought a requirement for a new body of knowledge such as avionics.

Opposite right: The 1950s was a time of great change for many AMEs and technicians. The training and experience many of the senior AMEs had was no longer so effective in maintaining the new jet aircraft.

was that some company management personnel did not really train them or offer training on the new systems but moved that work over to the new avionics specialty. This caused problems which had to be addressed in later years.

The 1960s really brought the issue of how aviation maintenance work in the airlines would be organized and conducted. The steady advances in using electronics to solve mechanical engineering problems continued at a fast pace. Developments in transistor technology and miniaturization of circuitry added to the speed of integrating electronics into aircraft systems. Since many of the older AMEs did not have a lot of mathematical or basic electronics training something had to happen. Companies really weren't that interested in re-educating older workers. What happened was the advance of the classical instrument, electrical, armament systems type trades into a new trade called Avionics.

This meant that work associated with the overall authority of the basic "A" licence was infringed on for very good reasons, but it was a limiting factor to the "A" licence category. This was most apparent in larger airlines who could afford to become more specialized in their trade structure. The military, which had always had sub-trades, was not as quickly affected since they could staff large crews. In addition, military requirements had to account for wartime losses among maintenance crews and rapid deployments to operational areas. The growth of the avionics specialization was not that apparent in business or general aviation. Category "A" or "R" AMEs became more exposed to avionics and tended to be more complete aircraft types. In this they were supported by many small independent avionic maintenance facilities employing avionics technicians.

Flight Engineers

Small groups of licenced AMEs worked in a sub section of the flight crews, and were called Flight engineers. In my early air carrier days I worked with many of them. They normally were the best and brightest of us AMEs who wanted a flying job. They became very knowledgable of all aircraft systems and were a great value in troubleshooting snags. When not flying, the Flight Engineers would engage in ground training of

both AMEs and pilots. They were eventually forced out of the cockpit by automation. But before that happened, many of the flight engineer positions were filled by a third pilot, which lead to more pilots acquiring systems knowledge and experience. Advancing automation based on computers and electronics soon eliminated them too, and today most transport category aircraft only require two flight crew members. Some of us noticed great differences between the old AME types of Flight engineers and pilot types.

For pilots it was a stop on the way to another position as First Officer or Captain. For AMEs it was a prestige job at the top of the career path. They took a real interest in technical issues and were a great help to us. The era started with them being employed on piston engine bombers and transports. After the war they continued in many civil aircraft such as Boeing 707s and other similar types.

Helicopter AME Development

Most early helicopter technicians had their start in the military. At one time all three services operated helicopters in Canada and overseas. A few long time friends of mine

The light aircraft used in flight training schools, small air charters and air operators, provide reasonable working conditions. Some of the small fixed base operations who provide maintenance to many owner/ operators have also built substantial faculties.

In Canada the general aviation AMEs form a large part of the bedrock of aviation maintenance in that they maintain some 27,000 or more light aircraft.

had their start in the army, others in the navy and air force. Today I believe all helicopters in the Canadian armed forces are operated by Air Force personnel. It was not long before community colleges had both helicopter flight and maintenance training departments, and today most technicians come from that source.

There was a time before the current M1 and M2 category AME licencing system that we had an independent "R "category. In my opinion the "R" category licence served us well as I found a large difference between fixed wing and rotorcraft work. However, that was the past and today it seems to work well as type training is still required at the approved maintenance organizational level. I recently was able to visit a certified helicopter repair and overhaul organization and witness the number of certified trades employed to rebuild the aircraft.

General Aviation

I am using the term "general aviation" in the American sense of business and light aircraft use, including amateur and homebuilt, balloons, and other non transport category aircraft. In Canada the general aviation AMEs form a large part of the bedrock of aviation maintenance in that they maintain some 27,000 or more light aircraft under difficult financial working conditions. The light aircraft used in flight training schools, small air charters and air operators, provide reasonable working conditions. Some of the small fixed base operations who provide maintenance to many owner/operators have also built substantial faculties.

The main difference between AMEs in large operations and in the General Aviation field seems to me to lie in the greater responsibilities for immediate knowledge of all the aircraft systems and of many types of aircraft. The general aviation AME is certainly an independent individual who operates without all the back-up that large systems provide. They also share many working conditions with bush and helicopter AMEs as many of their hangers and workplaces are small and can be cold or hot as the seasons change. In other cases they operate from modern facilities on major airports. The field is vast and diversified.

General aviation AMEs are seen to be jacks of all trades. That is they are competent trouble shooters, sheet metal and engine technicians. To work on light aircraft one has to be multi skilled in all aspects of aircraft work. This is because the General Aviation owners and operators do not have the depth of facilities to rely on. They do depend on the manufacturers and network of independent suppliers. However, to be successful in maintaining light aircraft one needs to accomplish most work in house.

Next issue I will deal with the many interesting challenges I faced when responsible for licensing AMEs and regulating manufacturing and maintenance in Canada. ■

*(The entire text of this series can be found at **Roger Beebe's** website, **www.planetalkconsulting.com**)*

PACIFIC

Pacific AME Association

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).

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

1. Work shop and meetings annually on topics of interest to AMEs.
2. Opportunity to meet and exchange ideas at our functions.
3. 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.
4. Corporate Members are entitled to advertise that they are members of AME Association.
5. Opportunity for employment networking at our workshops.
6. Free advertising of your company on our website.
7. Free job postings on our website.
8. Two corporate members able to attend our workshops.

www.pamea.ca

WESTERN

Western AME Association

About Our Association

The Western AME Association is run by a volunteer group of AMEs who are elected by the member AMEs to the Board of Directors. The membership is comprised of AMEs, non-licensed personnel working in the industry, students and apprentices as well as corporate members.

Member Benefits

1. Members of WAMEA get outstanding, exclusive benefits like:
2. Complimentary subscriptions to several Canadian Aviation magazines.
3. The annual Symposium & Trade Show.
4. Mini-courses for AME training at the Symposium.
5. Mini-meetings during the year on topics of interest to AMEs.
6. Opportunity for input to and consultation with Transport Canada.
7. Opportunity to meet and exchange ideas at our functions.

www.wamea.com

CENTRAL

Central AME Association

About Our Association and Objectives

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.

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.

www.camea.ca

AME Association of Ontario

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

Annual General Meeting

Our AME Association of Ontario Annual General Meeting (AGM) will be held on Monday, September 20th at 7 pm. We will be holding the meeting in a virtual or combined small group – virtual format depending upon what health regulations will be in force.

The AGM will have the standard agenda items including a financial report, members report and election of board members. A notice to all active association members will be sent advising of on-line login procedures and other meeting information. Additional information can be found on our website https://ame-ont.com/ .

Annual Conference and Workshop

The Board of Directors, with the advice of the Conference Committee, has decided to go ahead with planning for our Annual Industry Conference and Workshop. The hotel and conference center has been booked for October 27-29, 2021.

At the moment we are planning for a full conference with up to 700 attendees and 50 exhibitor booths. A backup plan is in place if government regulations restrict attendance to a smaller number. The conference committee is optimistic and sees the need for a possible rapid return to demand for training and support in the aircraft maintenance field. More information along with the registration packages will be available on our website once details are finalized.

Maintenance Airworthiness Working Group

Several individuals from the regional associations represent AMEC/TEAC on the Transport Canada Maintenance Airworthiness Working Group. Meetings are held monthly by virtual conferencing. The goal of the group is to increase general aviation pilots and aircraft owners' knowledge of maintenance related subjects with the overall intent to improve safety.

At the March meeting the recent Airworthiness Directive concerning Piper low wing spars was discussed. Should you be involved with an aircraft subject to this AD, you may want to search for an AMO to supply the Eddy Current Inspection.

This link will provide access to Transport Canada lists:

https://wwwapps.tc.gc.ca/saf-sec-sur/2/CAS-SAC/aooas.aspx?typ=1&lang=eng
Under "Category" select NDT & under "Rating" scroll to "Eddy Current Inspection."
Pick your province and leave the other boxes blank.
Click "Search."

Submitted by **Stephen Farnworth**, for the Board of Directors

www.ame-ont.com

Atlantic AME Association

These are our Bylaws:

1. Membership privileges are available to all members in good standing with dues paid to date. Lapsed membership may be re-instated with the payment of annual dues.
2. The Association President shall call Executive meetings as are deemed necessary. Normal notice of meetings shall be thirty days. Emergency meetings will be called as required.
3. Executive decisions can only be made with a quorum of 50% of the directors + one. Either the President or Vice-President must be included as one of the directors.
4. An annual meeting of the general membership will be held to normally coincide with the ARAMC .
5. All committee Chairpersons will report to the general membership at the Annual General Meeting.
6. An election of executive officers will be held annually at the general meeting. In the event that an elected committee chairperson resigns, for whatever reason prior to the expiry of his/her term, the President shall appoint another elected director to fill the position for the remainder of the resignee's term.
7. The Executive committee will be composed of a maximum of ten (10) and a minimum of six (6) directors who will manage the affairs of the Association.
8. Half of the executive will be elected at each AGM. All nominations must be accompanied with one signature of a member in good standing. Elections will follow the nominations. Nomination Forms must have the nominee's signature of acceptance of the nomination or the acceptance can be verified by phone call or e mail from the nominee.
9. If a serving member of the executive is nominated to another position on the executive, he/she shall tender their resignation upon accepting the nomination.
10. Elections will be by secret ballot.
11. Members serving on the Executive should be prepared to offer their service for two years and attend executive and other meetings as required.
12. The president will not be a voting member, with the exception of a tie-breaking vote. 13. An agenda will be required for the AGM for discussion and action on items proposed during the year, and will be mailed thirty days in advance.
14. Membership fees (regular, student and corporate)will be established on an annual basis by the members at the AGM.
15. Any amendments to the AME Association Objectives or By-Laws will be approved by the general membership at the AGM.

www.atlanticame.com

CENTRAL OHIO

Central Ohio PAMA

Flight Safety Detectives (episode 69)
ERAU students leading safety research

Embry-Riddle Aeronautical University masters students share details from their research into safety issues in aviation. Greg and John make connections between the research and their own experiences.

They go in depth on the issue of carry-on bags in cases of aircraft evacuation. Research has generated quantitative data on how passengers impact safety when they avoid the advice to leave carry-on bags behind.

Other research highlights the importance of safety management systems in all areas of transportation. SMS make safety a core value and provide an effective tool for managing any kind of business.

The students also reflect on their paths to pursuing interests in aviation and safety.

www.copama.org

SOCAL

PAMA SoCal Chapter

Who we are

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

SoCal PAMA News Brief Spring 2021

The SoCal PAMA Board of Directors Virtual Meeting March 12, 2021 included:

1. State of the industry (recovering)
2. Live trade shows scheduled for 2021 (AEA, NBAA)
3. Local A&P schools reopening (TBA)
4. Venue & safety protocols for 2022 Chapter meetings (planning)
5. Chapter finances (review)

Thank You to Aircraft Window Repairs for another generous donation to the Chapter Scholarship Fund during this difficult time. To make a tax-deductible donation to the Chapter Scholarship or Operating Fund, Or to post a job opening or event
Contact **Dan Ramos** SoCalPAMA@gmail.com

www.socalpama.org

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TC Feedback

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

Beechcraft King air. Failure of the rudder pedal arm at the brake pedal pivot holes.

REPORTS AND COMMENTS

Report: Beechcraft King Air A100
Failure of the rudder pedal arm.

Subject:

Pilot reported that the aircraft was hard to steer. Maintenance found the pilot's right-hand rudder pedal arm had broken off where the pedal is attached to the arm.

Transport Canada Comments:

This rudder pedal design is common across multiple Beechcraft models. Part Numbers 50-524326 (all dash numbers) and P/N 002-524020 (all dash numbers).

Beechcraft does include detailed inspection criteria and possible bushing insert repair instructions. Multiple Service Difficulty Reports (SDRs) continue to be submitted regarding excessive wear or failure of the rudder pedal.

Transport Canada Civil Aviation recommends particular attention be given during scheduled inspection. Wear may be difficult to estimate or cracks may go unnoticed while the pedals are still attached.

Report: Boeing 737
Wheel assembly missing/broken tie bolts

Subject:

During the take-off roll, at approximately 120 to 130 knots, the crew reported that they heard a bang followed by a vibration and decided to reject the take-off. When maintenance arrived at the aircraft, they confirmed that the number 1 and 2 tires had blown and that damage was also found to the wheel halves. The cause of the tire blowout was unknown, but all affected components were changed out and sent to the appropriate vendor for assessment.

The number 1 and 2 wheel assembly halves were found still held together by the tie bolts. The number 1 wheel assembly had four sheared tie bolts and all the bolts appeared to be intact on the number 2 wheel assembly. The wheel fuse plugs on both wheel assemblies were inspected and found to be intact.

Boeing 737. Wheel showing wheel damage and missing tie bolts. Sheared tie bolt showing fracture at threads.

The aircraft servicing history was reviewed and no abnormal servicing issues were noted since the installation of the wheel and tire assemblies. All wheel assemblies and the number 1 and 2 brakes were replaced to return the aircraft to service.

Transport Canada Comments:

Investigation by the shop concluded all the bolts from this event were as follows:

1. All bolts were evaluated and met specifications for hardness, coating and material (H-11 steel) with no indications of a batch or quality issues.

2. The cause of the six fractured bolts was found to be fatigue. Four bolts were found with cracks initiating from the 8th to 9th thread root and two bolts were found with cracks initiating from the under-head radius transition area.

3. No abnormal cause of the fatigue cracking was detected (corrosion, mechanical damage).

4. Overload fractures detected on three of the six bolts were assumed to have occurred during the take-off roll.

5. No indication of bolt stretch was observed.

The original equipment manufacturer was contacted and reported that they were unaware of any problems with tie bolts in industry. The operator initiated a fleet campaign replacement of all bolts, and limited the bolts to less than the OEM recommended service life, in an effort to prevent these issues. The reduced service life program has worked and reduced the failure frequency. One SDR has been reported since July 2016 where a loose bolt was found during maintenance.

Report: Bombardier CL-601 Tire Failure Event(s)

Subject:

After a normal landing, a bumpy taxi ride was noticed and the flight crew suspected a blown tire. A closer inspection, after taxiing to the ramp, revealed that the #1 main wheel tire had lost a good portion of its tread. The runway where the landing occurred was inspected for rubber by the airport authority and no rubber debris was found. We were unable to confirm if the tire tread loss had occurred during departure or landing.

The affected tire had accrued 163 landings since installation and was new upon installation. No other damage was visible and there were no skids or severe cuts noted so it is suspected there may have been a possible bonding issue.

Transport Canada Comments:

There have been 35 similar events reported in the Service Difficulty Report (SDR) database since 1993 with 16 events occurring in the last 3 years. The trend shows an increase in the number of events with three in 2014, six in 2015 and seven in 2016. No events have been reported as of May 2017. The events were also split over the various aircraft models as follows: two on the 601 Variant, two on the 601-3A Variant, and twelve on the 601-3R Variant.

Many of these events were limited to tread separation and the tire continued to remain inflated. A number of these events occurred on tires with relatively low in-service time. Of the twelve events that occurred in 2015 and 2016, we received five SDRs with time in service information. The reported time in service for the affected tires were: 168, 163, 82, 77 and 57 landings.

It is possible that pre-landing damage or wear may have existed in some of the events reported. This SDR notes, "No other damage was visible" and that, "a good portion of the tread was missing" so pre-existing damage may have existed and was lost with the tread. Upon viewing the attached picture, the center tread area is showing some wear with the center grooves almost gone. Many of the events occurred on the CL-601-3R model so it may be expected that tire service life will be less, possibly due to this model's higher gross weight.

Transport Canada Civil Aviation is publishing this article to raise awareness that a detailed pre-flight inspection is extremely critical for this tire and aircraft combination.

Report: DeHavilland Dash 8 Burnt Terminal Block

Subject:

During ground maintenance, the #1 engine generator feeder cables were found fused at the engine firewall terminal block. Damage to the firewall was sustained, requiring replacement of the firewall in that area.

Transport Canada Comments:

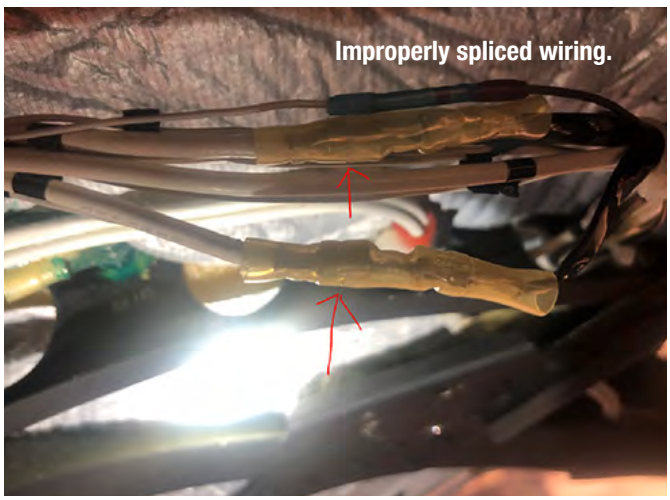
It is unknown what caused the feeder cables to short and burn the firewall, however, these images show the kind of damage that can be caused by large cables shorting and burning. On high current cables, sometimes the damage is already done by the time the protection devices trip and the power to the affected circuit is cut. Loose connections on these cables can cause overheating of the terminal blocks and should be checked for proper torque during inspections.

Report: Pilatus PC-12
Improper Wiring Practices

Subject:

During a routine inspection of the windshield heat wiring and splice crimps, it was noted that the left-hand pilot windshield wires were crimped improperly. This is what this inspection was designed to look for, after finding some windshields that were installed improperly. The two separate splice crimps were found to have been crimped backwards.


Properly spliced wiring.


Improperly spliced wiring.

Transport Canada Comments:

This special inspection proved its worth. Sometimes routine maintenance can seem mundane and uninteresting. This particular maintenance staff was able to find the exact issue the inspection was calling out. Following procedure and being attentive during inspections can save a crew from an in-flight failure.

Report: Robinson R44 II
Overhaul oversight leads to damaged landing gear component.

Subject:

During run up, it was noted that the idle was high (around 70% belts engaged). Upon inspection, it was found that the bearing had come out of the part number (P/N) B564-2 link at the servo end.

Pre R44 SB-71 throttle link P/N B564-2 having aluminum-bronze bearing races.

Transport Canada Comments:

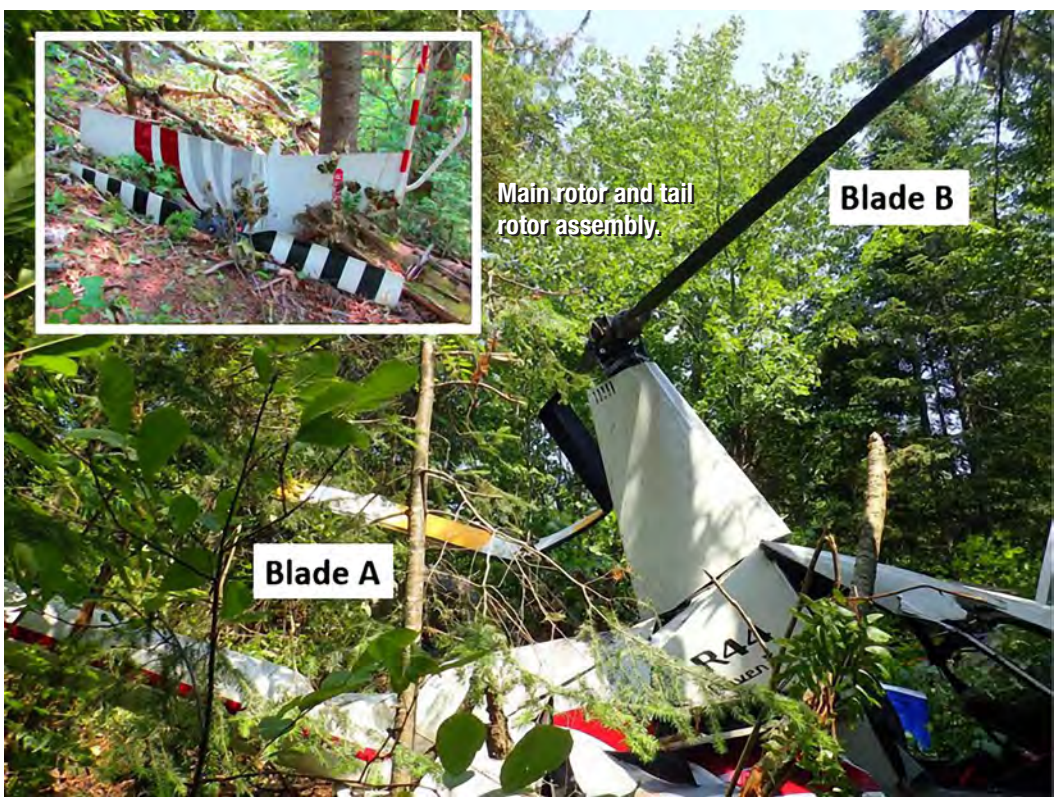
It should be noted when inspecting or replacing throttle link P/N B564-2 for the R44 and R44 II model helicopters, that the Robinson Helicopter Company has published multiple service bulletins for this service difficulty.

R44 Service Bulletin (SB)-62 identifies a failed throttle link where the bearing separated from the housing. Compliance with this SB involves the installation of a large-diameter washer to prevent loss of control if a bearing fails. The incorporation of the large-diameter washer is also published in the Robinson Illustrated Parts Catalog throttle control installation.

R44 SB-71 introduces a throttle link with a TeflonTM-lined steel bearing race designed to prevent race separation from the link body. This SB requires replacing the earlier links having aluminum-bronze races while retaining the large-diameter safety washer requirement. ■

(The articles contained in Feedback are derived from Service Difficulty Reports submitted by Aircraft Maintenance Engineers, owners, operators and other sources in accordance with Canadian Aviation Regulation 521.)

Main Rotor Failure in Flight

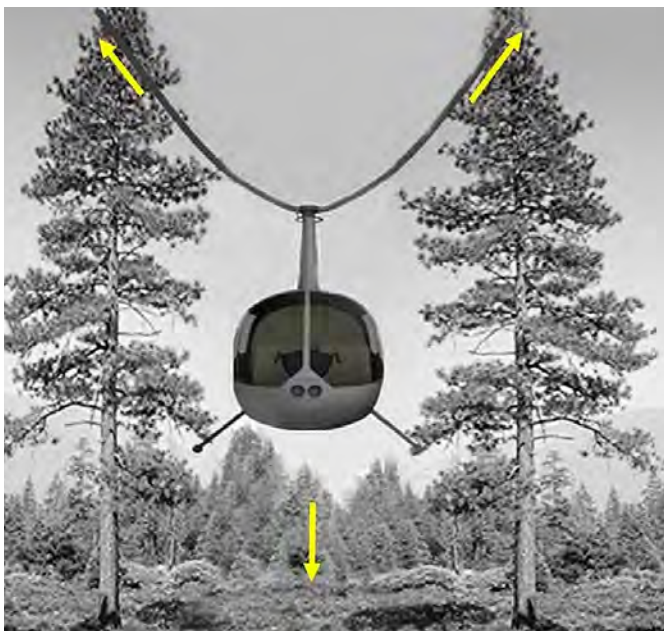


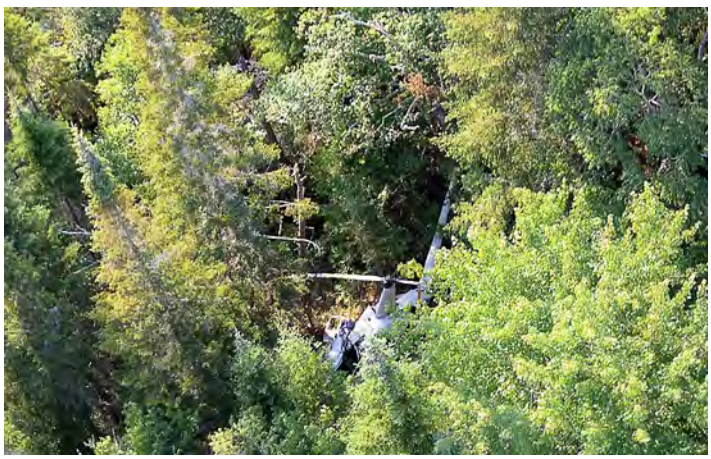
Adhesive debonding is the destructive element in this tragic tale from Quebec.

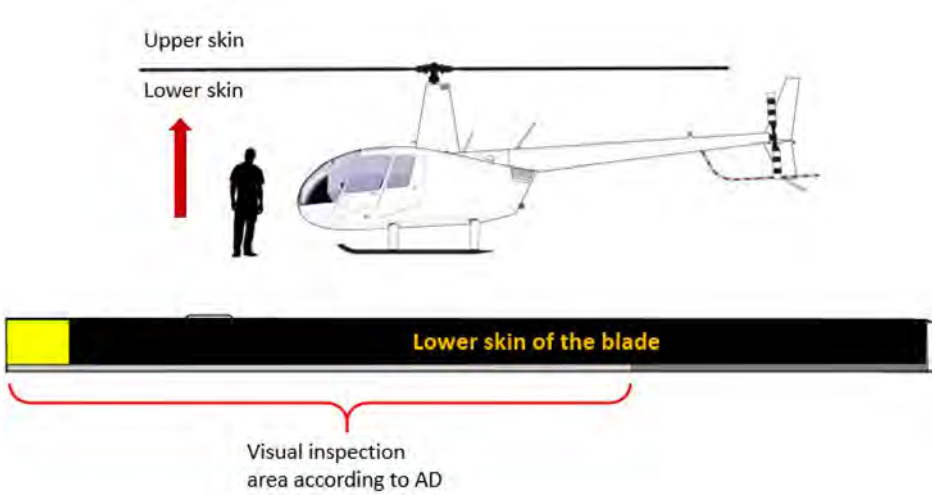
ON **08 JULY 2019**, the pilot of a privately registered Robinson R44 helicopter (registration C-FJLH, serial number 2044) conducted a visual flight rules (VFR) flight from his residence in Sainte-Sophie, Quebec, to his fishing camp at Lac de la Bidière, Quebec, with 1 passenger on board. Friends joined them by seaplane for a 2-night stay.

On the morning of 10 July, at approximately 1000,1 the pilots began preparations separately for a departure around noon to their respective destinations. The seaplane took off first, at approximately 1225.

Weather was favourable for conducting a VFR flight and there were no surface winds over the lake. The Québec flight







Left: Illustration of the interaction between immobile main rotor blades and trees during a vertical drop. Above: Aerial view of C-FJLH. Below: Area of the lower skin on a blade to visually inspect.

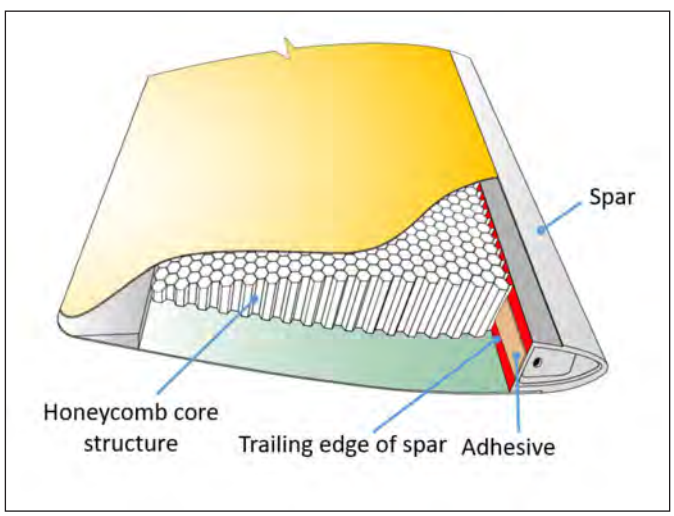
service station (FSS) did not receive a request for a weather briefing or a flight plan from the helicopter pilot. It is possible that the pilot used the Internet, available at his camp, for flight planning. Although his family members knew that he was planning to return to Sainte-Sophie on 10 July, the pilot did not specify the time of arrival and did not designate a person responsible for tracking the flight. The aircraft's estimated takeoff time was 1256. The Joint Rescue Coordination Centre (JRCC) in Trenton was not notified of the aircraft's disappearance until 1158 the next day, on 11 July, approximately 23 hours after the time of the accident, which was estimated at 1325. No emergency locator transmitter (ELT) signal was detected.

The JRCC dispatched a CC130 Hercules airplane and a CH146 Griffon helicopter to perform an air search, which was unsuccessful. On 12 July, the JRCC escalated the search level to "major", which allowed the Canadian Armed Forces (CAF) to increase their air resources. The Sûreté du Québec (SQ), Canadian Coast Guard (CCG) and volunteer air search and rescue organizations in Quebec and Ontario also took part in the search.

On 21 July, after 11 days of intensive search efforts that were unsuccessful, the JRCC ceased its operations and withdrew all resources under its command. Responsibility for the search was then transferred to the SQ. Search teams finally found the aircraft on 25 July, 14 days after it was reported missing, in a wooded area near Lac Valtrie, Quebec. The occupants were found dead. The aircraft was destroyed.

DESIGN OF THE C016-2 MAIN ROTOR BLADES

The main rotor blades mounted on C-FJLH at the time of the accident had been manufactured by the Robinson Helicopter Company (RHC) and bore part number C016-2. They consisted primarily of an aluminum alloy honeycomb core structure, bordered along the front by a stainless steel spar forming the leading edge and a trailing edge doubler in the back. A stainless steel skin covered the components above (upper skin) and below (lower skin) the blade, and was bonded to

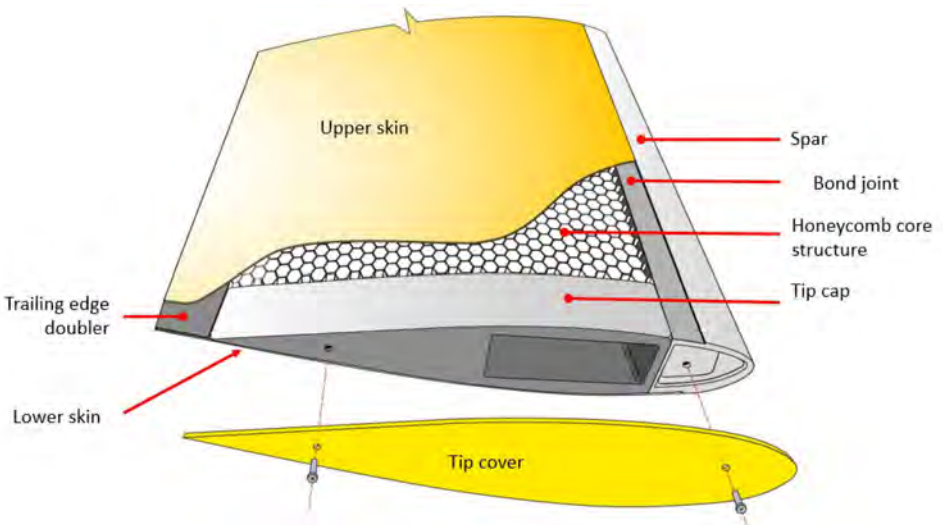


the trailing edge doubler, the honeycomb core structure and the spar.

These blades had a known tendency to debond at the adhesive bond joint between the skin and the spar at the tip of the blade. Skin debonding can occur when the adhesive bond joint becomes exposed as a result of the top coat eroding or when corrosion appears below the internal aluminum tip cap. A blade is not considered airworthy if debonding, including microperforation, is detected along the bond joint.

In 2008, the U.S. National Transportation Safety Board (NTSB) issued 5 recommendations after 10 cases of debonding at the bond joint were discovered during maintenance inspections and visits between July 2006 and January 2007, and 4 cases of debonding occurred in flight in 2006 and 2007. These cases of debonding occurred far before the blades had reached their useful life of 2200 flight hours or 12 years, whichever came first.

In its report, the NTSB expressed its concerns about the absence of long-term durability testing for blade certification and the lack of reliability and effectiveness of the non-destructive blade inspection technique recommended by RHC to detect bond flaws. All of the known cases of debonding at



Top, far left: Debonding of the joint.

Below, far left: Diagram showing where the adhesive is applied between the trailing edge of the spar and the honeycomb core structure.

This page, left: Components of a C016-2 main rotor blade.

the bond joints only affected the blade tip and, in the most serious cases, resulted in sudden separation due to peeling of the blade skin in flight.

BONDING TECHNIQUE

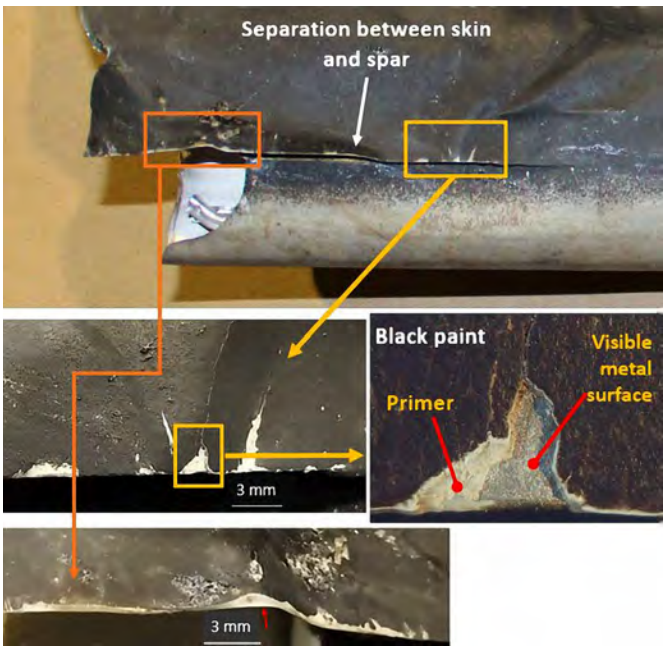
When the blades are manufactured, the upper skin and lower skin are overlaid at the bond joints along the spar, the trailing edge doubler and the tip cap, and held in place with a sprayed adhesive. The honeycomb core structure is also bonded to the trailing edge of the spar with the adhesive to ensure the solidity of the rotor blade. Since it is impossible to know the cohesive quality of an adhesive before a blade is assembled, the manufacturer exposed a few blades assembled from the same batch of adhesive to high stresses, to the point of failure, to determine the ratio of the number of cohesive failures10 to the number of adhesive failures,11 expressed as a percentage. Testing had to produce a result of at least 80% cohesive failures, otherwise the batch of adhesive and any blades assembled with it were destroyed.

A non-destructive inspection of the bond joints was also performed on the critical and non-critical parts of the blades once they were assembled. This inspection, commonly referred to as a tap test, consists of gently tapping the skin with a small hammer designed for this purpose, or a specific coin, and listening to the sound produced by the tapping. A change in sound may indicate an adhesive failure, among other things. The tap test is also used during maintenance inspections, and to date, it is the only non-destructive inspection technique recommended by RHC for detecting bond flaws.

WRECKAGE AND IMPACT INFORMATION

The aircraft was found in a vertical position on a rocky outcrop in a densely wooded area. The landing gear, the cabin roof, and the floor at the front of the cabin had collapsed. The windshield had shattered; the rear doors and the door on the pilot side had ejected, leaving only the passenger door still attached to its frame. The seat backs had collapsed backward and the seat cushions had sunk down. The front passenger safety belt, which included a lap belt and a shoulder harness, was found undone. There was fuel in both tanks.

The main rotor mast and rotor head were still attached to



Above: Enlargement of visible metal surfaces. Opposite, above: Google map of the incident site with TSB annotations.

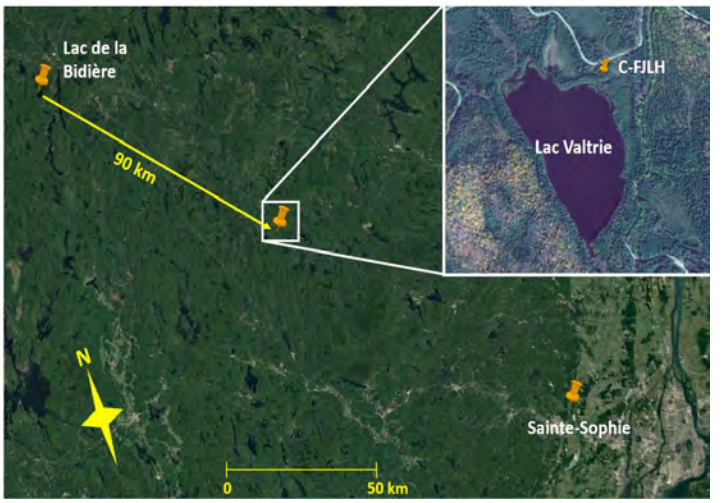
the main gearbox. The main rotor drive belts were in good working order and the belt tensioning mechanism was in the taut position. The main rotor blades did not show signs of the damage that is typically sustained on impact when the blades are rotating. One of the blades (blade A) was bent in several locations while the other blade (blade B) was straight but fractured at the tip.

Although the tail boom was damaged, it was still attached to the fuselage, and the driveshaft was still attached to the upper pulley of the drive system. The tail rotor assembly and horizontal and vertical stabilizers were separated from the tail boom. They were found approximately 6 metres from the wreckage, at the foot of a tree. The tail rotor blades did not show signs of significant damage.

Pieces of small branches covered the wreckage and the immediate area when the first responders arrived at the scene. The pilot's body was found inside the aircraft, in the pilot seat, with the seat belt fastened, while the passenger's body was found approximately 66 metres away. The aircraft debris was scattered within a short distance of the wreckage. TSB investigators found no trace on the ground or any other clues that could indicate the aircraft's longitudinal or lateral speed at the time of impact. Only the tree tops in the area above the wreckage showed signs of impact. The wreckage was transported to the TSB Engineering Laboratory for detailed examination.

EXAMINATION OF THE WRECKAGE

The fuel found in the tanks was uncontaminated AVGAS 100LL. The buckle on the front passenger's safety harness was working properly and did not show signs of major damage. An examination of the damage to the aircraft combined with information about the passenger's weight enabled investigators to estimate that the force of deceleration experienced by the passenger was between 17 G and 36 G.The force of deceleration experienced by the pilot could not be estimated; however, given that he was heavier than the passenger, it would have been much higher, giving him little chance for survival. The engine did not show typical signs that it was running at the time of impact. After a more detailed examination, there were no signs of mechanical failure or deficiency in the engine before the impact.



DAMAGE TO MAIN ROTOR BLADES

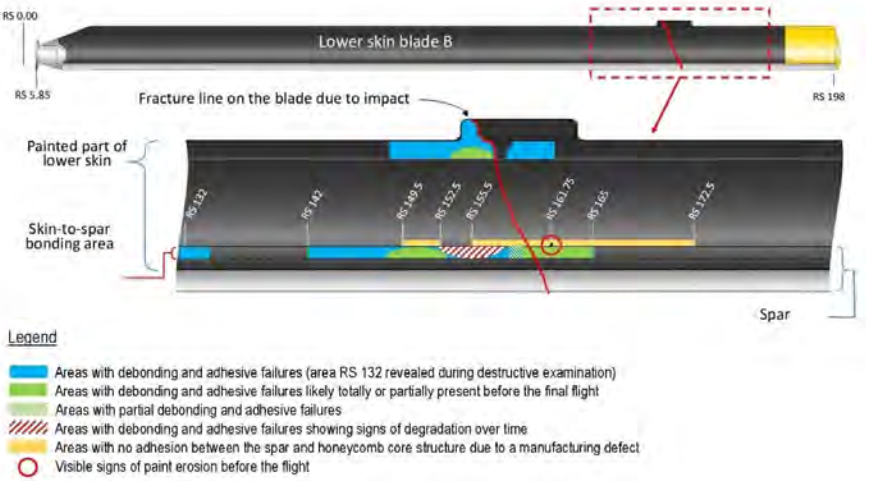
If a helicopter descends through trees while the main rotor is not turning, it is likely that the blades will undergo excessive upward bending from the pressure of the branches. This excessive bending causes deformations by compression of the upper skin only, meaning the upper side of the blade. The lower skin should show signs of scratches, nicks or dents from contact with branches.

An initial examination of the blades enabled investigators to identify deformations in the upper and lower skins, complete and partial fracture lines, and signs of impact with tree branches on the lower skin. The spar leading edges did not show signs of damage consistent with a blade in rotation when it came into contact with the trees.

EXAMINATION OF BLADE A

The numerous deformations across the skin on both sides of the blade suggest that the skin was subject to compression several times in flight. The deformations are consistent with damage created by excessive upward and downward bending of the entire blade. This flapping motion generally occurs when the centrifugal force that helps to keep the blades flat is reduced due to the blades' lower rotation speed. No signs of perforations or dents were found in the lower skin, indicating that there was no significant interaction between the blade and the branches during the descent.

Various areas where debonding was present.



EXAMINATION OF BLADE B

The blade was broken approximately 38 inches from the tip (station RS161). It had several fracture lines and many deformations in the upper and lower skin, consistent with excessive upward and downward bending motion and torsion. The examination showed that the deformations caused by excessive torsion likely occurred before those caused by excessive bending.

Close visual observation revealed that the metal surface of the joint was visible in a few locations along the spar near station RS161. Signs of debonding and gaps in the skin at the spar bonding joint were also noted. Although the lower skin had debonded from the spar after fracturing, the enlargement of these areas shows that air had caused the paint and its underlying layer to erode over time, and that the erosion was not the result of paint suddenly chipping as the skin separated at the spar bonding joint.

It is highly likely that the metal surfaces in these areas were visible and detectable before takeoff of the occurrence flight. The visual pre-flight inspection should be done in adequate lighting and at a suitable distance for signs of debonding to be identified, which may require use of a stepladder and a flashlight.

The presence of sap and traces of the impact on the lower skin indicate that the blade came into contact with small branches as the helicopter descended through the trees. Also, an examination of the marks left by these contacts revealed that the deformations caused by the torsion and bending motions happened before the blade came into contact with the branches; in other words, they occurred during flight.

It was established that the torsion increased progressively during the flight, which likely caused vibrations that increased in intensity until they became severe. This torsion significantly affected the blade's aerodynamic performance and the aircraft's manoeuvrability.

ADHESIVE FAILURE AT THE BOND JOINTS

A destructive inspection of the blade was performed to confirm the observed debonding of the skin. Separation of upper and lower skin samples confirmed the presence of several adhesive failures, of variable sizes, between stations RS132 and RS165.

The examination revealed that, in some areas, debonding of the skin had allowed humidity to infiltrate below the skin and weaken the adhesion to the bonding joint over time. In addition to the adhesive failures, there were several places where the adhesive on the surface between the honeycomb core structure and the trailing edge of the spar did not have the usual imprints found when there is contact between them. This was true over a cumulative length of 20 inches, indicating that the condition had been present since the blade was assembled and was the result of a manufacturing defect.

FINDINGS AS TO CAUSES AND CONTRIBUTING FACTORS

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence.

1. It is likely that during the occurrence flight, a sudden increase in adhesive failures contributed to significantly reducing the stiffness of one of the blades, causing excessive vibrations.

2. It is likely that a manufacturing defect contributed to reducing the stiffness of the blade, which increased the vibrations in flight caused by the multiple adhesive failures.

3. The rotational speed of the main rotor fell too low, preventing the aircraft from remaining in flight. This was followed by a vertical drop and impact with the ground.

4. It is likely that when the last inspection was performed in April 2019, the adhesive failures were already present and went undetected by the tap test.

5. Exposed metal surfaces at the skin-to-spar bonding joint were present and likely visible to the naked eye on one of the blades before the occurrence flight. ■

(The preceding were excerpts from the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 10 March 2021. It was officially released on 31 March 2021.)

Aviation Services

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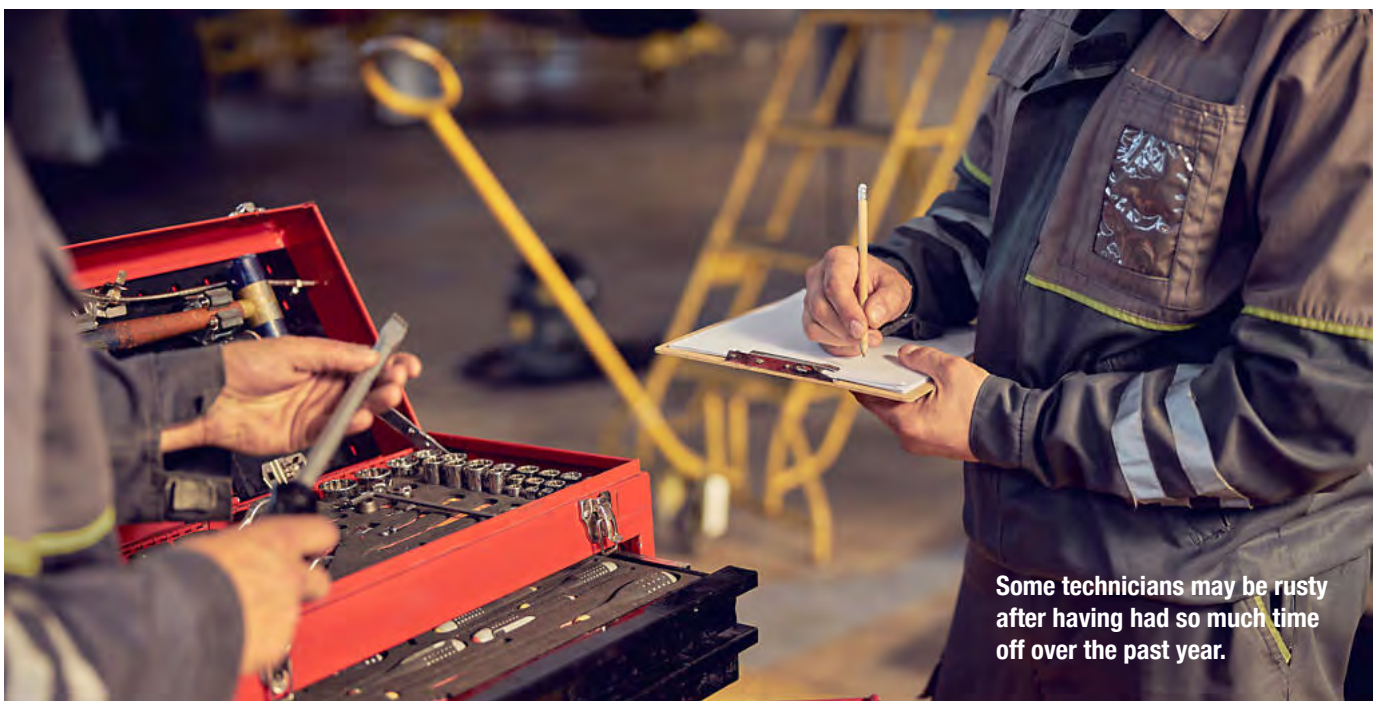
BY MATTHEW VAN WOLLEN

Emerging from the Pandemic

Is your air operation ready when life finally gets back to "normal?"



Some technicians may be rusty after having had so much time off over the past year.

IT'S SAFE TO SAY NOBODY PLANNED for the historic disruption in operations that COVID-19 brought about over the past year. Faced with an unprecedented drop in demand seemingly overnight, many air operators were forced to put expansion plans on hold, make difficult decisions about staffing and park unused aircraft. While the pandemic has not yet fully run its course, today the green shoots of a recovery are visible. Are you ready?

Bringing furloughed workers back may seem straightforward—especially for flight crews, who have been flying occasionally to maintain currency requirements. But when it comes to aircraft maintenance technicians, there are two challenges you may need to think about: the readiness of aircraft and the resilience of maintenance crews.

Parking the aircraft for an extended period interrupts operational cadence. Airplane inactivity and the lack of regular in-service maintenance checks can lead to a loss of component lubrication, the discharge of batteries, contamination of fuel tanks and loss of pressure in hydraulic systems or tires, among other potential problems.

In addition, if the aircraft was exposed to the outside environment while parked, it may have sustained damage from heat, humidity, ice, hail, sandstorms or even insects. For this reason, external openings on the airplane such as relief valves, vents and ports should be inspected as part of the return-to-service process to ensure they are clean and free of environmental contaminants.

The second challenge in ensuring air operation readiness is the human factor. During normal operations, maintenance crew schedules are structured and overtime work periods are usually limited in number and duration. But maintenance is driven by the demands of the flight operation. If a customer needs to get somewhere on short notice, the pressure is immense to ensure the aircraft is airworthy in time for departure. If the aircraft has been parked, this can be a problem.

There are no shortcuts in the procedures for returning the aircraft to service, so all that work may need to be compressed into a short amount of time. Compound this issue by several aircraft returning to service at about the same time and also by the fact that your maintenance worker bench strength may be limited (not just in number—some technicians may be rusty after having had so much time off over the past year), and you have the makings of significant fatigue risks among your maintenance crew members.

To help mitigate the risk of errors by fatigued maintenance workers, consider investing in a fatigue risk management program (FRMP). ■

Matthew van Wollen is Chief Financial Officer for Pulsar Informatics, Inc.

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