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Aviation Safety Letter

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TP 185E

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Canada

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Aviation Safety Letter survey: We want to hear from you!

Transport Canada (TC) created the *Aviation Safety Letter* (ASL) to serve the aviation community as a safety and awareness educational tool. We are looking for your feedback as a reader about whether the content is relevant, useful, and meets safety awareness expectations.

Your input is important to us so that we can continue to improve the ASL.

All responses are anonymous, and data is aggregated for reporting purposes. The survey will take 5 minutes to complete. △

Transport Canada's continued work on strengthening aviation safety across the Americas and Caribbean States

by Shannon Wright, Civil Aviation Safety Inspector, Technical Programs & Evaluation, Standards, Civil Aviation

Transport Canada Civil Aviation (TCCA) works hard to promote a safe and secure aviation system in Canada, but did you know that we are also promoting the safety of Canadians abroad? Recognizing the global and interconnected nature of an aviation system used by so many Canadians who travel for business and leisure, Canada continues to lead in the strengthening of aviation safety across the Americas and the Caribbean States through engagement with the International Civil Aviation Organization's North America, Central America and Caribbean (ICAO NACC) Regional Office.

In 2018 TCCA and ICAO signed a Memorandum of Collaboration (MoC) that sets out the basis for collaboration between TCCA and ICAO through its NACC Regional Office. Under this MoC, cooperation activities include:

- Provision of experts to help provide direct technical assistance and training;
- Evaluations and surveys;
- Assistance with documentation review/revision and legislative matters; and,
- Assistance with development plans and projects.

Since its signing, our two organizations have been working collaboratively on harmonized assistance activities across the region. With the goal of helping States across the Americas to achieve a level of safety similar to that in Canada, our technical experts mentor and provide guidance through special training courses and workshops; share best practices and lessons learned on current issues, needs and targets; and provide in-country training where we work alongside national specialists to train and share knowledge.

Why are the Americas and Caribbean a priority for us?

Many of these small island countries that Canadians love to visit (particularly in winter), do not have the means or the expertise required to continuously improve aviation safety, so outside assistance is required to ensure aviation safety in the region continues an upward climb. Given the notable positive impacts of fulfilling these assistance missions, we are on our way to achieving our aviation safety goals.

Strengthening aviation safety in developing countries also supports the Government of Canada's priorities of global poverty reduction through international sustainable development, as well as TC international engagement objectives supporting cooperation with developing regions. Currently, Eastern Caribbean Civil Aviation Authority (ECCAA) States are a priority in ICAO's *No Country Left Behind* Initiative and given that Canada is part of the NACC Region, it makes sense to give support and aid to our regional neighbours.

TCCA looks forward to continuing its collaboration with ICAO NACC in advancing aviation safety across the NACC region. Even with the unforeseen circumstances due to COVID-19, technical assistance activities continue. Below are some highlights.

Developing Haiti's Safety Oversight System –Systemic Assistance Programme

Beginning onsite in April 2018, TCCA is providing technical assistance in safety oversight for the Haitian Civil Aviation Authority (OFNAC).

To start, Haiti's Effective Implementation of ICAO Standards and Recommended Practices was just 6%. As a result of Transport Canada's technical assistance, the Haiti national law "*Code de l'Aviation Civile*" was adopted in 2020, the Haitian Civil Aviation Regulations were implemented, and a safety culture was promoted through a strong partnership and mentoring of OFNAC technical personnel. Additionally, the following major outcomes were achieved:

- Training of Haitian Aviation Inspectors
- Certification and Surveillance Manual for Operations inspectors developed and implemented;
- Certification and Surveillance Manual for Airworthiness inspectors developed and implemented;
- Aircraft Leasing Manual developed and implemented;
- Haiti Surveillance Plan for 2020 developed and implemented;
- Inspection of all leased aircraft operating in Haiti.

Assistance to Improving Aviation Safety of the Eastern Caribbean Civil Aviation Authority (ECCAA)

In October 2020, TCCA worked with the ICAO NACC Regional Office and other subject matter experts to provide technical assistance to the ECCAA and Other Eastern Caribbean States (OECS) in building an appropriately organized, funded and empowered civil aviation organization that is structured to effectively carry out its safety oversight functions and duties. Multiple subject matter experts conducted a review of the current structure and operations of ECCAA to identify weaknesses and develop recommendations in an effort to increase their levels of aviation safety.

In addition, Transport Canada is assisting ECCAA in applying safety risk management principles to improve decision making to address COVID-19 challenges and support safe aircraft operations. △

Service difficulty reporting and general aviation

by Shawn Gauthier, Civil Aviation Safety Inspector, and Tim Stubbert, Civil Aviation Safety Inspector, National Aircraft Certification, Civil Aviation

Transport Canada's General Aviation Safety campaign (GASC), recently transitioned to a General Aviation Safety Program. The goal of the campaign, now program, is to increase the overall safety of the general aviation sector in Canada. One of the offshoots of this program is the Voluntary Reporting Working Group. The Voluntary Reporting Working Group (VRWG) was established in June 2018 as part of the GASC. The original mandate of the VRWG was to:

1. Research and develop a voluntary reporting system to be used by GA pilots; and,
2. Research and develop a voluntary reporting system to be used by Flight Training Units.

The topic of Service Difficulty Reporting (SDR) joined the working group's conversations and was immediately identified as an important component to GA safety and viability. Service Difficulty Reporting provides Transport Canada and other civil aviation authorities an essential view of the health and safety of the aircraft flying in our skies.

General aviation being the largest sector of aviation in Canada, one would think that Transport Canada would have tremendous amounts of SDR data to comb through to discover trends in GA aircraft failures, malfunctions and defects. They do not. GA SDR reporting is the least frequent when compared to all other sectors of aviation in Canada. Service Difficulty reporting is also not mandatory for GA. But does that make it any less important? TC says no. Let's take a look at what an SDR is and what the SDR system is comprised of in order to get a better understanding.

Service Difficulty: failure or malfunction of, or defect in, an aeronautical product.

Aeronautical Product: an aircraft, aircraft engine, aircraft propeller or aircraft appliance or part, or a component part of any of those things.

Reportable Service Difficulty: a service difficulty that affects or that, if not corrected, is likely to affect the safety of an aircraft, its occupants or any other person.

From the definitions above you can see that, if it is attached to an aircraft and it is likely to affect safety, it is a reportable service difficulty, and TC would love to hear about it.

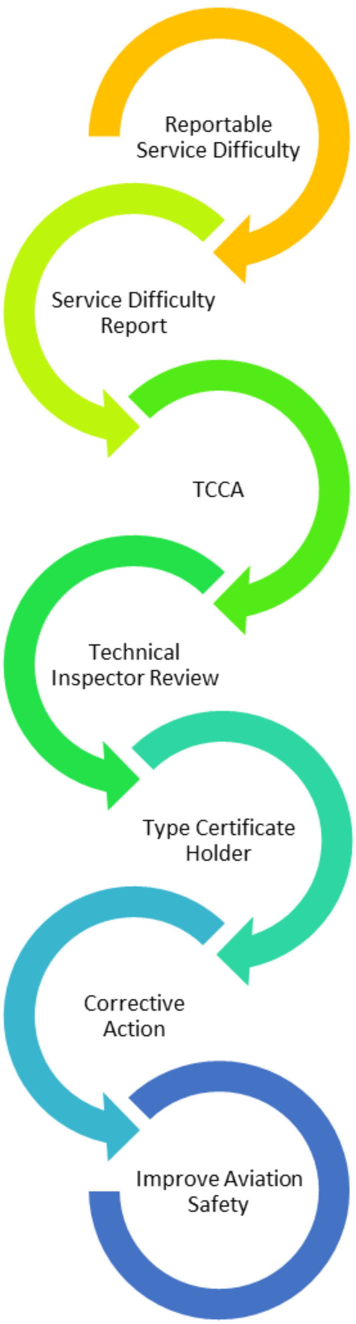
TC has published Advisory Circular AC 521-009 to help the Canadian aviation community better understand the SDR system. The AC gives examples of reportable defects and help for submission.

Here is an example of a submitted Canadian SDR.

> *SDR 20160502010 - PIPER PA28 140*
> *PART NAME: YOKE PART NUMBER: 6201903*
> *PILOTS CONTROL YOKE UPPER L/H SIDE, CLOSE TO WHERE THE PUSH TO TALK SWITCH IS MOUNTED, CRACKED ALL THE WAY THROUGH IN FLIGHT, THE YOKE REMAINED INTACT*

AND THE AIRCRAFT WAS CONTROLLABLE. CRACK IS NOT IN THE AREA OF INSPECTION REQUIRED BY AD 69-22-02 AND PIPER SB 527D

This example displays the perfect SDR submission. The submitter provides the part name, number and a great description of what the event entailed. Additionally, the submitter ties in an existing Airworthiness Directive and Service Bulletin related to similar defects noted in the SDR.



Continuing Airworthiness, In-Service Investigation division of the National Aircraft Certification branch of Transport Canada Civil Aviation is responsible for all SDRs submitted in Canada. In 2019 there were 4 727 SDRs submitted to TC from Canadian owners, operators, maintainers and AMOs.

In-Service Investigation has seven Corrective Action Technical Inspectors (CATI) that review every Service Difficulty Report that is submitted either through the Web Service Difficulty Reporting System (WSDRS) or by fax/paper submission. These Technical Inspectors (CATIs) are divided by product, product type, and by type certificate holder. When an SDR is submitted, the CATI responsible for that product reviews it for completeness and overall safety impact. When the review is complete, the CATI then forwards the SDR to the type certificate holder responsible for the subject aeronautical product. As an example, an SDR submitted for a Cessna 172 would be reviewed and forwarded to Textron Aviation. This process is the same for engines and propellers.

What does TC do with all those SDRs? Routinely, SDRs materialize into larger projects. For TC, SDRs are often the corner stone of Airworthiness Directives, Civil Aviation Safety Alerts (CASA) and Feedback Articles—all forms of Corrective Action. The Service Difficulty reporting program provides for the collection, organization, analysis, and dissemination of aircraft service information to improve service reliability of aeronautical products. It is one of the most important tools TC has to gauge the safety and reliability of Canadian registered aircraft. Regularly, the above mentioned CATIs perform analysis on the SDR data to discover trends in the defects submitted.

In addition to Canadian SDRs, the WSDRS database contains SDRs submitted from the United States and Australia. In total there are over 1 937 336 SDRs in the database. The CATIs work closely with TC's Continuing Airworthiness Corrective Action Engineers to determine if the rate and severity of the reported defects match TC's definition of an unsafe condition. This is when an Airworthiness Directive is created. Down the severity scale, a CASA is the next publication that can originate from SDRs. A CASA is used to convey important safety information and contains recommended action items. A CASA is not mandatory like an AD, but the actions contained within are highly recommended. The third tier is a Feedback Article. Feedback articles are a safety awareness communication tool used by TC for the aviation community. These articles are directly created from submitted SDRs and chosen by the above CATIs as events of interest.

In addition to Transport Canada's corrective action options outlined above, SDRs are routinely utilized by the Type Certificate Holder to initiate a corrective action or product improvement. These may be in the form of Service Bulletins, Information Letters, or Instructions for Continued Airworthiness (ICA) updates just to name a few.

A good way to think of the impact SDRs have on safety is to compare them to a TSB report. A TSB accident report is reactive in nature, where SDR reporting is proactive risk management. The main objective is to get ahead of the defect.

How does general aviation tie in to all of this? SDR reporting is not mandatory for GA. It also isn't mandatory for AMEs. Who is required to submit? As per the *Canadian Aviation Regulations*, the following are required to submit SDRs:

- CAR 573—Aircraft Maintenance Organizations (AMO);
- CAR 406—Flight Training Units (FTU);
- CAR 706—Air Operators;
- CAR 604—Private Operators;
- CAR 521—Design Approval Holders, and
- CAR 561—Manufacturers of Aeronautical Products.

Who can submit SDRs? Anybody. Transport Canada allows for the submission of SDRs by any person who feels the need exists to submit. The WSDRS is the quickest way to submit, but fax and mailing of an SDR is always welcome.

- SDR Form 24-0038 is available through Transport Canada's Forms Catalogue.
- Access to the WSDRS system.

The WSDRS website contains many other useful links. A user can gain access to Airworthiness Directives, CASAs, Feedback magazine website link and access to the fax/paper copy of the SDR form. Owners and maintainers may also find an added benefit of the system by using the immense data base of SDRs to search for submissions for their product type. These submissions may contain useful defect rectification techniques used by the submitter to rectify a similar defect.

What is the direct benefit to GA community? Improved safety. SDRs simply improve the safety of you, the operator of GA aircraft, and of the entire worldwide aviation community.

In closing, Transport Canada's Service Difficulty Reporting System is highly recommended for all members of the aviation community. For the general aviation and AME sector it is completely voluntary, but it provides a valuable tool to help keep aviation safe in Canada. △

Remotely Piloted Aircraft Systems (RPAS), otherwise known as drones

by Shaheen Chohan, Aviation Safety Policy Analyst, RPAS Task Force, Civil Aviation

Remotely Piloted Aircraft Systems (RPAS), otherwise known as drones, have become increasingly popular over the last several years. Advances in technology have made drones an increasingly efficient and effective tool for conducting inspections, delivering cargo and medical supplies, and responding to emergencies. Like any change to a system, however, the introduction of drones to Canada's civil aviation system has created new hazards and challenges.

To mitigate the hazards associated with the growing number of drone operations, Transport Canada published Part IX of the *Canadian Aviation Regulations* (CARs) in January 2019, which outlines rules for flying drones in Canada.

The new regulations came into force on June 1st, 2019 and apply to drones that weigh between 250 g and 25 kg operated in visual line of sight. The rules introduce two categories of drones operations: basic and advanced. Each one has a different set of rules drone pilots must follow. To operate their drone in either category, pilots must register their drone online and mark their drone with their registration number. They must also obtain a pilot certificate by completing an online exam. Pilots who wish to conduct advanced operations must also successfully pass a flight review.

Here is a simplified version of the two operating environments and some of the associated rules:

	Basic Environment	Advanced Environment
Altitude	under 400 ft AGL	as approved by air traffic control (if within controlled airspace; otherwise under 400 ft AGL)
Airspace	outside of controlled airspace	within controlled airspace*
Proximity to people	More than 30 m away	More than 5 m away*
Over people	no	yes*
Proximity to airports	more than 3 NM	at or near airports**
Proximity to heliports	more than 1 NM	at or near heliports**
Proximity to uncertified aerodromes	at or near uncertified aerodromes	at or near uncertified aerodromes
Night operations	with appropriate lighting	with appropriate lighting

*the drone must meet the appropriate safety assurance profile and the pilot must have permission from NAV CANADA

**advanced drone pilots flying at or near airports and heliports must follow the established procedure for drone operations.

Regardless of operating category, a drone pilot must ensure they fly their drone within their visual line-of-sight (VLOS), away from emergency operations and advertised events, and far away from other aircraft.

Drones that weigh less than 250 g, also known as microdrones, are not required to be registered and pilots are not required to have a pilot certificate in order to operate. Regardless of size, however, all drones must be flown in a way that does not pose a risk to aviation or people on the ground.

Photo credit: iStock

One fundamental change from other sections of the *Canadian Aviation Regulations* (CARs) is the elimination of the distinction between commercial and recreational users. Part IX of the CARs applies to every drone pilot regardless of the purpose of their mission.

As pilots, it is our job to mitigate risk. Drones are a new entrant to the National Civil Air Transportation System and as such, their emergence has created a new risk: collisions between drones and traditional aviation. It is the responsibility of drone pilots to remain clear of areas within which traditional aircraft operate, and to keep their drone in control and in sight so that when another aircraft is detected they're able to take immediate action to give way. However, pilots of traditional aircraft should understand the operating environment Part IX of the CARs created for drone operations, so they can plan their flights in a way that further reduces risk. Avoiding collisions is a responsibility all pilots share. To further minimize the risk of a collision, pilots of traditional aircraft should avoid flights below 400 ft AGL in uncontrolled airspace and take additional care to fly standard circuits at uncertified aerodromes, as that is where other airspace users are going to expect aircraft to be.

The full integration of drone operations into our airspace will take some time, but eventually drones will be as commonplace in our skies as traditional aviation. For more information on drones and drone safety, please visit the Transport Canada Drone Safety website. △

David Charles Abramson Memorial (DCAM) Flight Instructor Safety Award

Unfortunately, due to the COVID 19 pandemic, there will not be a DCAM Flight Instructor Safety Award nomination for 2020. Hopefully, we will see the prestigious DCAM once again honoring and recognizing Canada's outstanding and exceptional flight instructors in 2021.

In the meantime, I encourage you to visit the DCAM website to learn about the history of the DCAM, and also to see the list of past recipients of the award.—Ed. △

RECENTLY RELEASED TSB REPORTS

The following summaries are extracted from final reports issued by the Transportation Safety Board of Canada (TSB). They have been de-identified. Unless otherwise specified, all photos and illustrations were provided by the TSB. For the benefit of our readers, all the occurrence titles are hyperlinked to the full report on the TSB Web site. —Ed.

TSB Final Report A19P0059—Engine power loss, forced landing into trees

Summary

On 04 May 2019, the Cessna 182E was conducting a fire surveillance flight under daytime visual flight rules (VFR). The flight was being conducted on behalf of the BC Wildfire Service in the vicinity of Smithers, B.C., with the pilot and three crew members on board. Approximately 3 hours (hr) into the flight, the pilot transmitted a Mayday before communication was lost. The 406 MHz emergency locator transmitter (ELT) activated on impact and its signal was received by the Canadian Mission Control Centre. A helicopter search was conducted and the aircraft wreckage was located in a forested area approximately 50 nautical miles (NM) north of Smithers, 500 feet (ft) north of the Babine River, 5.6 NM east of the Silver Hilton Steelhead Lodge airstrip[1]. The aircraft had collided with trees and terrain. One crew member survived the crash and was transported to hospital by helicopter. The pilot and the other two crew members were fatally injured. The aircraft was destroyed; there was no post-impact fire.

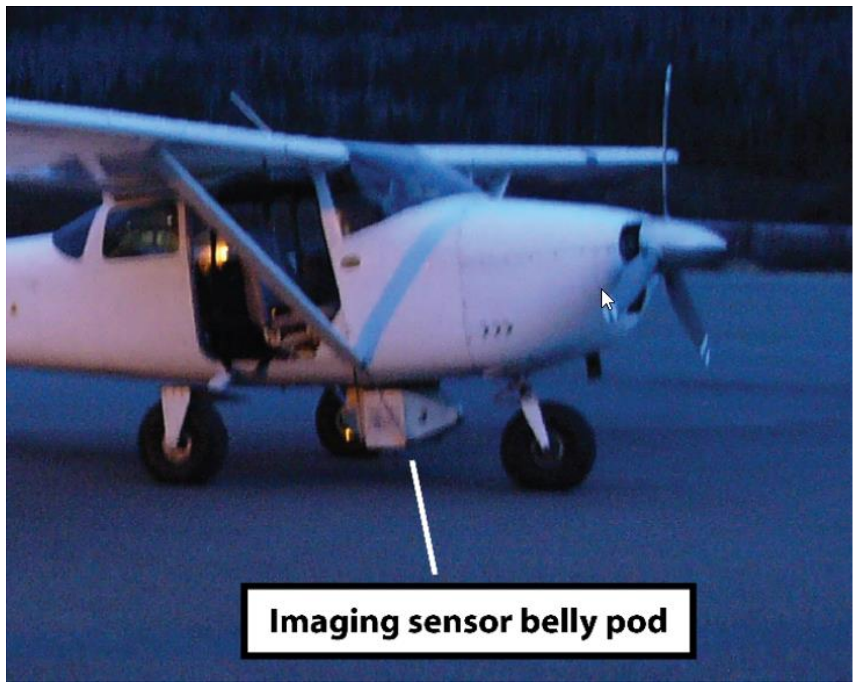


Figure 1. The occurrence aircraft on the morning of the accident with imaging sensor belly pod installed (Source: Precision Vector Aerial Inc., with TSB annotation)

[1] The Silver Hilton Steelhead Lodge airstrip is a private gravel and grass airstrip at a fishing camp on the Babine River. The airstrip, which measures about 1 800 ft in length, is rough, and only about 1 200 ft of it are useable. The pilot had not landed at Silver Hilton Steelhead Lodge before and, because the belly pod was installed, the aircraft was not approved to land on unpaved airstrips.

Factual information

Background

On 30 April 2019, four days before the occurrence flight, the pilot and the three crew members arrived at Burns Lake, B.C., to prepare for conducting fire surveillance flights on behalf of the BC Wildfire Service. The occurrence aircraft, was already at the Burns Lake Airport (CYPZ).

On 01 May 2019, an imaging-sensor-equipped belly pod was installed on the aircraft (Figure 1), as per Supplemental Type Certificate (STC) SA4-662. On 02 and 03 May, flights were conducted to test and calibrate the scanning equipment to detect underground hot spots in areas of previous fire activity.

During those flights, it was determined that the best scanning results were obtained when the aircraft flew at a height of between 3 000 and 4 000 ft above ground level (AGL) and a groundspeed between 80 and 90 kt. It was also determined that the scans were best performed early in the day, before solar heating of ground objects resulted in erroneous infrared signatures.

History of the flight

At 05:41 on 04 May 2019, the occurrence aircraft departed CYPZ with the pilot and three crew members on board. The purpose of the flight was to scan for hot spots in three areas of previous fire activity. The aircraft was carrying full fuel, which allowed for a flight endurance of approximately 5.5 hr.

The aircraft flew from CYPZ to the first scanning site, approximately 50 NM north-northwest, where it conducted scanning passes for 51 minutes (min) while flying between 2 500 and 3 100 ft AGL.

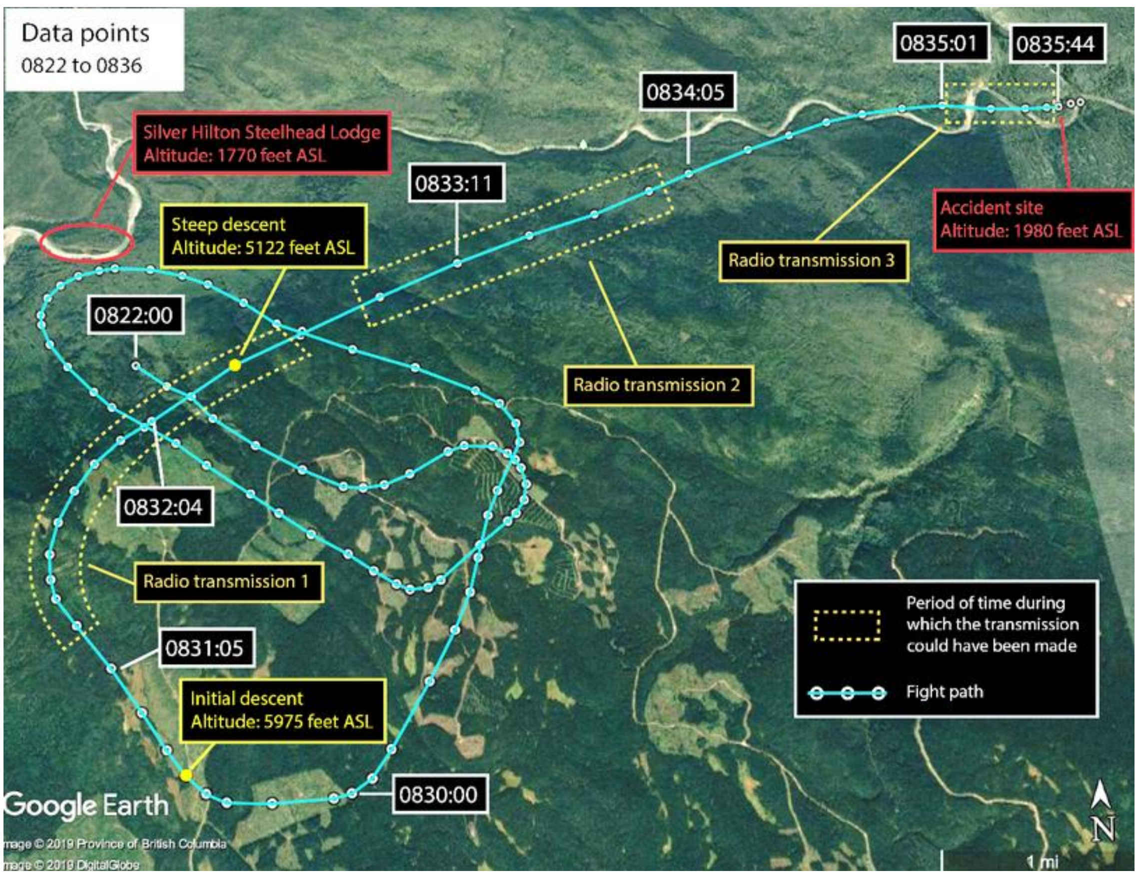


Figure 2. Flight path of the occurrence aircraft (dotted line) with associated events (Source: Google Earth, with TSB annotations)

The aircraft then continued 36 NM further north-northwest to the 2nd scanning site, 86 NM from CYPZ and about 48 NM north of Smithers. Radio check-ins confirmed normal operation, including a check-in at 08:21, after more than an hour of scanning in the 2nd area. Shortly after that radio check-in, the aircraft's engine performance degraded.

At 08:32, the pilot advised the Northwest Fire Centre (NWFC) dispatchers that the aircraft would be landing at the Silver Hilton Steelhead Lodge airstrip, which was located approximately 2.5 NM to the northwest (Figure 2, radio transmission 1).

At 08:33, the pilot transmitted a Mayday call to the NWFC dispatchers indicating that the flight would be unable to reach the Silver Hilton Steelhead Lodge airstrip and stated that he would "land 5 miles west" of the airstrip (Figure 2, radio transmission 2).

At 08:35, a final transmission from the pilot was received giving the position of the aircraft (latitude and longitude) and stating that the aircraft would be landing in the trees (Figure 2, radio transmission 3). Less than 1 min later, the aircraft crashed into a forested area adjacent to the Babine River. The 406 MHz ELT activated on impact and transmitted a signal, which was received by the Canadian Mission Control Centre (CMCC). The CMCC then relayed the information to the Joint Rescue Coordination Centre (JRCC) Victoria.

Shortly after the pilot's last radio transmission, the NWFC enacted its emergency response plan, which included dispatching three helicopters from Smithers to search for the occurrence aircraft.

The 1st helicopter arrived at the aircraft's last reported position at 10:36 and, approximately 20 min later, located the accident site about 0.4 NM northeast of the last reported position. A survivor was spotted near the wreckage. A 2nd helicopter, carrying a local search and rescue team and a Royal Canadian Mounted Police member, arrived overhead the site at 11:35 and was able to land nearby, reaching the survivor at 12:02. A third helicopter was dispatched and staged at the Silver Hilton Steelhead Lodge to provide additional support if required.

Figure 3. The occurrence aircraft at the accident site, with the right wing atop a tree (Source: TSB)

At 12:46, a search and rescue Cormorant helicopter arrived on scene. The survivor, who was seriously injured, was extricated using a hoist and taken to hospital.

Damage to aircraft

The aircraft struck multiple treetops along a nearly 500-ft-long path eastbound before striking a large tree trunk and descending steeply, coming to rest nose-down at the base of a small berm. The aircraft was destroyed due to collision with trees and terrain (Figure 3).

Personnel information

Records indicate that the pilot was certified and qualified for the flight in accordance with existing regulations. The pilot had passed his last medical examination on 26 April 2019, 8 days before the accident. The pilot had completed recurrent training and a pilot competency check on the aircraft 4 days before the accident. Training at the company suggested that forced landings at times of the year when rivers have higher water levels and are flowing faster should be made into trees, not water.

Aircraft information

General information

The occurrence aircraft, a Cessna 182E manufactured in 1962, was a four-seat, high-wing monoplane of primarily aluminum construction. The aircraft was originally equipped with long-range fuel tanks (84 U.S. gallons [gal.], 78 U.S. gal. useable).The investigation determined that the aircraft was within weight and balance limits during the occurrence flight.

Records indicate that the aircraft had an ongoing history of carburetor air box repairs and alternator-related maintenance.

Meteorological information

On the day of the accident, the graphic area forecast (GFA) issued for the area surrounding Smithers at 04:31 and valid at 05:00 for 12 hr, provided the following weather forecasts:

- Broken clouds 14 000 ft with tops at 18 000 ft above sea level (ASL)
- Scattered clouds 4 000 ft with tops at 8 000 ft ASL
- Visibility of more than 6 statute miles (SM), with localized areas of visibility of ½ SM, and freezing fog and cloud ceilings at 500 ft AGL

This forecast was available to the pilot before the flight's departure from CYPZ; the investigation could not determine if he accessed it, however. The upper wind forecast for Smithers Airport valid from 02:00 to 11:00, at 6 000 ft ASL, were westerly at 21 kt.

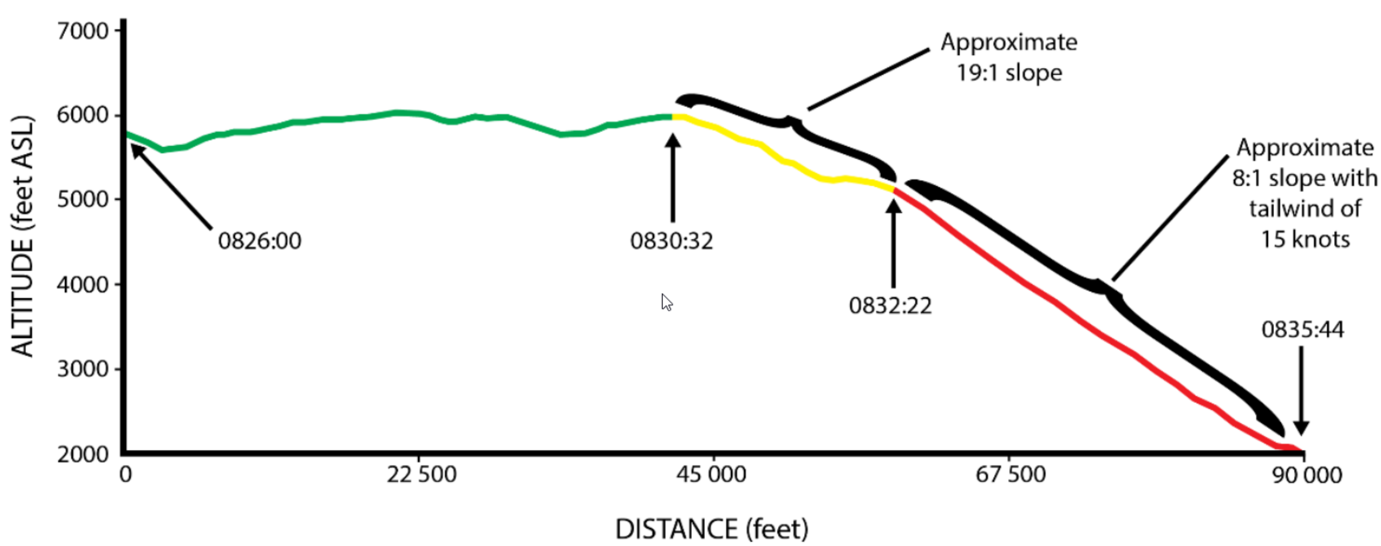


Figure 4. Occurrence aircraft altitude profile for the last 10 min of the flight

The nearest weather station to the accident site was Nilkitkwa, B.C., about 14 NM east-southeast, situated at 3 180 feet ASL and maintained by BC Wildfire Services. At 08:00 and 09:00 respectively, the Nilkitkwa weather station recorded surface temperatures of 6.5 °C and 6.7 °C with dew points of −0.7 °C and −1.0 °C. The surface temperatures at Smithers Airport, about 48 NM south at 1 716 ft ASL, were 8.8 °C and 10.8 °C, with dew points of 1.6 °C and 0.8 °C. Surface winds at these two locations were predominantly from the north-northwest at less than 10 kt.

Two cameras recovered from the accident site contained photographs taken during the accident flight. A photo taken while the aircraft was scanning in the second area, about 42 min before the accident, shows rain showers around the aircraft. A photo taken about 13 min before the accident shows the aircraft's outside air temperature (OAT) gauge reading 45 °F/7 °C. GPS (global positioning system) information indicates that the aircraft altitude at that time was about 5 600 ft ASL.

Aids to navigation and aircraft performance

The flight was conducted under visual flight rules and in daylight visual meteorological conditions. The aircraft was equipped with a GPS. Data from this GPS were recovered and are presented in Figure 4.

The maximum glide chart in the 1966 Cessna 182J owner's manual indicates a power-off glide ratio of about 10:1 with the propeller windmilling and the flaps retracted.

Wreckage and impact information

The wreckage was located about 500 ft north of the Babine River, about 5.6 NM east of the Silver Hilton Steelhead Lodge airstrip. At the time of the accident, the Babine River was in freshet and, as a result of the fast-flowing high water, almost no gravel bars or open shorelines were visible.

The mixture control was fully in (full rich mixture), and the propeller control was fully in (full fine pitch).

Both wing tank fuel caps were found secured. The fuel selector valve was selected to "both," and no contamination was found in the fuel lines or the carburetor. The carburetor air box was crushed at impact and no determination could be made of its pre-impact condition. However, the carburetor heat control remained connected to the carburetor air box and was found in the fully-in (cold) position. At impact the control had been bent at 90° immediately forward of the instrument panel, trapping the centre control wire in the "carb heat cold" position. Measurement of the flap screw jack showed that the flaps were fully extended at impact.

The aircraft wreckage was recovered from the accident site and examined by TSB investigators. The engine was sent to a certified overhaul facility for examination with TSB investigators in attendance.

The engine could not be run on a test stand, primarily because of extensive crushing damage to the oil pan, so the engine was torn down and inspected. No pre-impact mechanical defects were found that would explain a total or partial power loss. However, several anomalies were found.

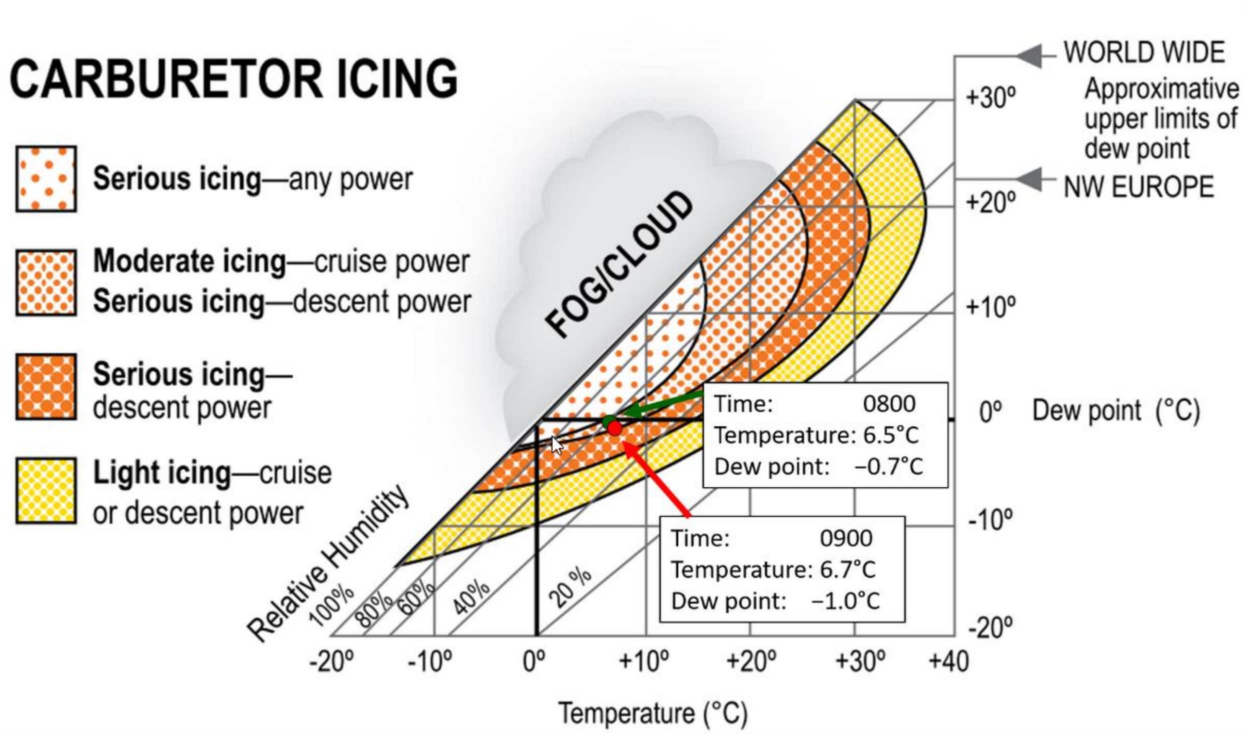


Figure 5. Carburetor icing potential based on ground-level weather conditions at Nilkitkwa, BC (Source: Transport Canada, TP 14371, Transport Canada Aeronautical Information Manual [TC AIM], *AIR – Airmanship [10 October 2019], subpart 2.3, with TSB annotations)*

Additional information

Carburetor icing

Carburetor icing is a phenomenon where water vapour in the air freezes and adheres to internal surfaces of the carburetor. This occurs because the temperature of air entering the carburetor is reduced by the effect of fuel vaporization and by the decrease in air pressure caused by the Venturi effect. If the air temperature in the carburetor drops below freezing, ice may form on internal surfaces of the carburetor, including the throttle valve.

Use of partial power increases the likelihood of ice buildup on the throttle valve and decreases the exhaust system heat available for the anti-ice system. Use of richer mixtures increases the cooling effect of fuel vaporization. As ice forms, this increases the Venturi cooling effect due to narrowing of the carburetor throat and this narrowing reduces power output. If significant ice is allowed to develop within the carburetor and full heat is applied to melt it, the resultant water flow through the engine causes the engine to run rough and to lose further power and may even cause the engine to quit. Unchecked, the ice can quickly lead to a complete engine failure. To overcome carburetor icing, aircraft manufacturers provide a system to heat the incoming air and prevent ice accumulation. To help determine whether atmospheric conditions are likely to produce carburetor ice, charts that compare outside temperature and dew point have been produced (Figure 5).

The chart indicates that, based on the temperature and dew point at the weather station 14 NM from the accident site at the time of the occurrence, the conditions were conducive to serious carburetor icing even at cruise power. Although the dew point at the aircraft's location is not known, nearby rain showers indicate humidity at least as high as that at the weather station. When a dew point is not precisely known, the presence of precipitation should indicate to pilots that atmospheric conditions are high in relative humidity. Furthermore, the likelihood of accumulating carburetor ice increases as both relative humidity increases and air temperature decreases towards 0°.

Ice that forms in a carburetor during flight rarely remains after a crash, making carburetor ice difficult to identify as a cause of power loss. Nonetheless, accidents and incidents involving carburetor icing are prevalent in aviation.

Analysis

Introduction

The pilot was medically fit and qualified for the flight. The aircraft had sufficient fuel for the intended flight. No performance issues had been reported for almost 3 hr of the flight. No pre-impact mechanical defects were found that would explain a total or partial power loss. As a result, this analysis will focus on the effects of carburetor icing.

Carburetor icing

The engine teardown did not reveal any mechanical cause for an engine power loss.

There have been two recent accidents in the U.S. indicating carburetor icing on similar aircraft with the same engine modification, signalling that these aircraft may be susceptible to the accumulation of carburetor ice.

The temperature and humidity in the area where the flight took place were conducive to serious carburetor icing at any engine power setting. In addition, the mission required the aircraft to be operated at low groundspeeds, which necessitated a partial-power setting that made the occurrence engine even more susceptible to the formation of carburetor ice. The combination of the aircraft operating at a partial power setting and in atmospheric conditions conducive to carburetor icing likely resulted in ice forming in the carburetor.

The GPS (global positioning system) data shows that when the aircraft's performance started degrading, the aircraft started a shallow descent (about 19:1 glide ratio) that lasted for almost 2 min, consistent with partial engine power. This was followed by a steeper descent (about 8:1 glide ratio) that lasted for over 3 min, consistent with a complete engine power loss. The ice that likely formed in the carburetor would have initially reduced the engine's ability to produce enough power to maintain altitude and eventually led to a complete loss of power.

The carburetor heat control was found in the fully-in (cold) position. The pilot owned three carbureted aircraft and would have been familiar with the operation of carburetor heat systems, so it was unlikely that he would not have applied it in these circumstances. The investigation also considered other scenarios. Carburetor heat may have been selected on at some time before the crash but was likely returned to the cold position before impact. It is also possible, though less likely, that the carburetor heat control was returned to fully-in (cold) position when the carburetor air box was crushed at impact. If carburetor ice had indeed accumulated, it could not be determined why it would not have been removed or reduced by the carburetor heat system.

Forced landing

Following the initial engine problems, the pilot indicated an intention to land at Silver Hilton Steelhead Lodge airstrip; however, the aircraft tracked away from the airstrip, and the pilot reported that he would land west of it, when in fact the aircraft crashed east of it. The airstrip was not in the aircraft's GPS database, and, as a result, it is likely that the pilot was unable to locate it in sufficient time to conduct a safe landing before the engine failed.

The Babine River was in freshet and no gravel bars or open shorelines were visible. In such circumstances, pilot training at Lakes District Air Service Ltd. suggested forced landings should be made into trees, not water. These factors may have contributed to the pilot's decision to make a forced landing into trees rather than to ditch in the river.

Findings

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. The combination of the aircraft operating at a partial power setting and in atmospheric conditions conducive to carburetor icing likely resulted in ice forming in the carburetor.
2. The ice that likely formed in the carburetor would have initially reduced the engine's ability to produce enough power to maintain altitude and eventually led to a complete loss of power.
3. Following the initial engine problems, the pilot indicated an intention to land at Silver Hilton Steelhead Lodge airstrip; however, the airstrip was not in the aircraft's GPS database, and, as a result, it is likely that the pilot was unable to locate it in sufficient time to conduct a safe landing before the engine failed.

Findings as to risk

If aircraft equipped with carburetors are not equipped with a carburetor temperature indication system, there is an increased risk that pilots will not be aware that they are in conditions in which carburetor ice accumulation is possible and consequently will not take the appropriate remedial actions in time.

TSB Final Report A19W0105—Controlled flight into terrain

Summary

At 11:01 Pacific Daylight Time on 6 August 2019, A Cessna 208B Grand Caravan aircraft departed from Rau Strip, Y.T., for Mayo Airport, Y.T., on a visual flight rules (VFR) company flight itinerary The aircraft had one pilot, one passenger, and cargo on board. At 11:13, the aircraft entered instrument meteorological conditions (IMC) and struck rising terrain in a box canyon shortly after. The crash occurred approximately 25 nautical miles (NM) east-northeast of Mayo Airport, at an elevation of 5 500 feet (ft) above sea level (ASL) The Canadian Mission Control Centre did not receive a signal from the aircraft's 406 megahertz (MHz) emergency locator transmitter. Eyewitnesses from a nearby exploration camp arrived at the site after approximately 1 hour. The Royal Canadian Mounted Police and emergency medical services arrived on site approximately 90 minutes (min) after the accident. The pilot and passenger received fatal injuries. The aircraft was destroyed; there was a brief post-impact fire.

Factual information

On 6 August 2019, the Cessna 208B Grand Caravan aircraft was scheduled to depart from Mayo Airport (CYMA), Yukon, at 08:30 to conduct four flights under VFR (Figure 1):

- The first flight was from CYMA to Rackla Strip, Yukon.
- The second flight was from Rackla Strip to CYMA.
- The third flight was from CYMA to Rau Strip, Yukon.
- The fourth flight was from Rau Strip to CYMA.

The first three flights would be conducted with only the pilot on board. A passenger boarded the aircraft at Rau Strip for the fourth and final flight to CYMA.

The pilot completed the first two flights with no issues. The highest flight altitudes recorded on the onboard global positioning system (GPS) for these flights were 7 500 and 8 500 ft ASL, respectively. The highest terrain along the direct route between Rau Strip and CYMA is approximately 6 500 ft ASL.

The aircraft departed from CYMA on the third flight at 09:54. A portion of the recorded track was along Granite Creek at an altitude of 4 200 ft ASL, which put the aircraft 100 to 200 ft above ground level (AGL) at the highest point along Granite Creek. The investigation was unable to confirm if the pilot had obtained weather information before departing from CYMA for Rau Strip.

The aircraft was observed flying eastbound along Granite Creek at low altitude and in reduced visibilities due to rain and cloud at about 10:05. The onboard GPS measured an altitude of approximately 200 ft AGL, near the observers.

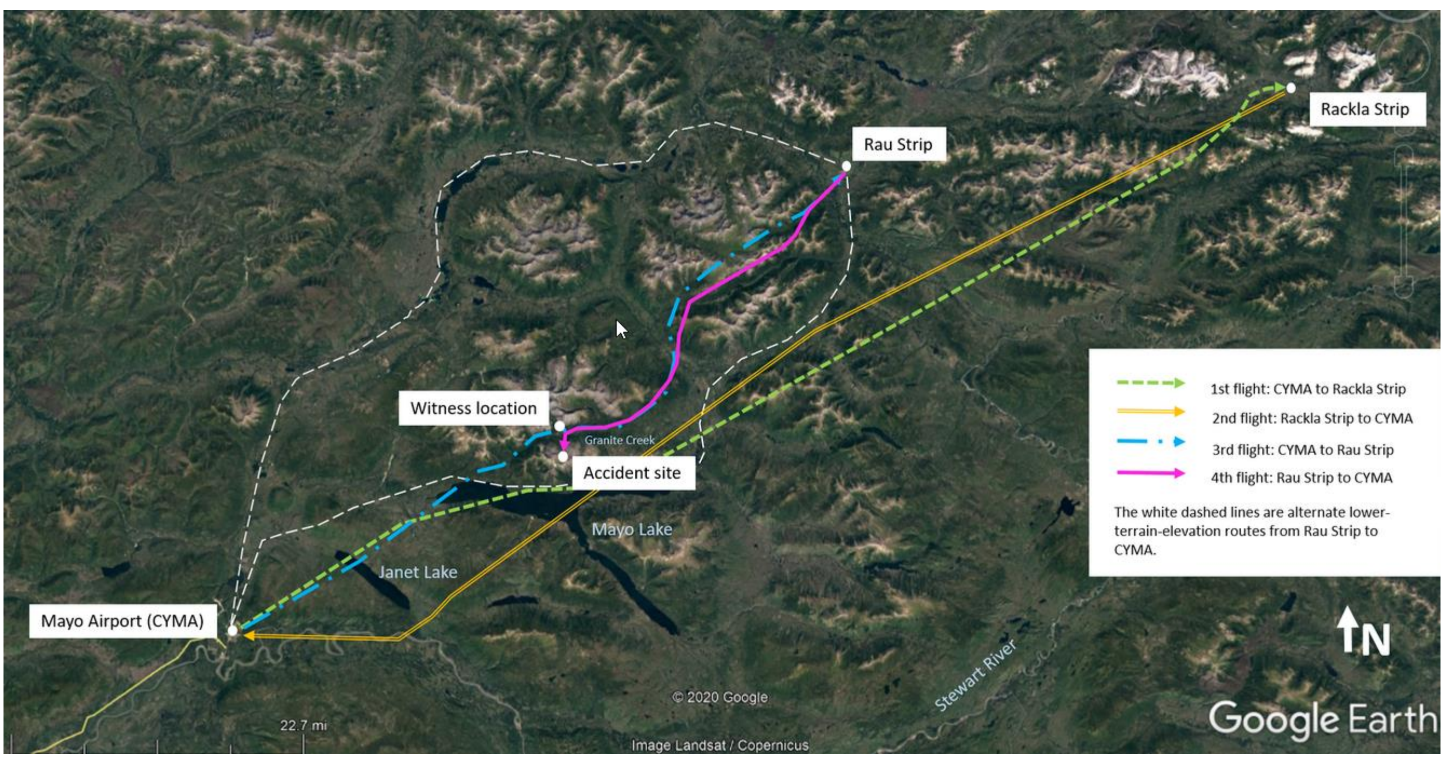


Figure 1. Flight path data

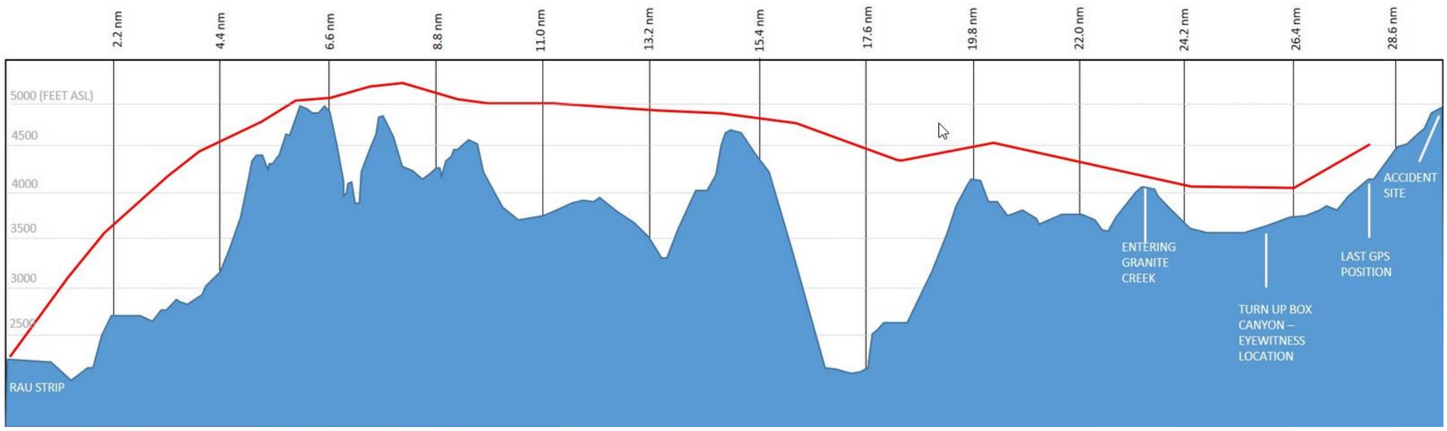


Figure 2. Profile view of accident flight showing GPS altitude (red line) compared to Google Earth terrain elevation

The aircraft arrived at Rau Strip at 10:17, where the cargo was unloaded and different cargo loaded. A passenger boarded the aircraft for the final flight and was seated in the right seat in the cockpit. The aircraft departed from Rau Strip at 11:01.

The route of the fourth flight from Rau Strip to CYMA was the reverse of the previous flight. The aircraft entered Granite Creek at 4 300 ft ASL and was flying at a ground speed of 156 knots (kt) (Figure 2). Eyewitnesses at an exploration camp approximately halfway along Granite Creek heard and then observed the aircraft flying at near treetop level. The cloud bases to the west of the exploration camp were at treetop level.

As it passed the exploration camp, the aircraft turned south into a box canyon, departing from the intended route. It headed toward rising terrain that led to the north face of Mount Albert. The aircraft began to climb and shortly thereafter was observed to disappear into the clouds and fog at 11:12, approximately 1 NM from the accident site. The aircraft impacted terrain approximately 30 seconds (s) later, in a near wings-level attitude with the flaps in the up position. The two occupants were fatally injured on impact. The aircraft was destroyed.

Damage to aircraft

Both wings partially detached from the fuselage and the left elevator separated from the horizontal stabilizer. The engine separated from the firewall and all four propeller blades were broken free from the propeller hub. There were signs of a small post-impact fire on the outboard portion of the left wing.

Personnel information

The pilot held a commercial pilot licence and valid Category 1 medical certificate, as well as a valid instrument rating. The pilot began training as a captain on the Cessna Caravan at the end of March 2019 and he was released as a qualified captain on the aircraft on 11 May 2019.

Records indicate that the pilot was certified and qualified for the flight in accordance with existing regulations. Based on a review of the pilot's work and rest schedules, fatigue was not considered to be a factor in this occurrence.

Aircraft information

The Cessna 208B Grand Caravan is a fixed-landing-gear, unpressurized, single-turboprop aircraft that is certified to carry cargo or up to nine passengers. At the time of the occurrence, the aircraft was configured for cargo. The aircraft is approved for operation by a single pilot or by two pilots and is certified for flight into forecast icing.

The weight and centre of gravity were calculated by the TSB to be within the prescribed limits for all portions of the occurrence flight from takeoff to impact. The investigation estimated the weight at the time of the accident to be approximately 6 800 pounds (lbs). A pilot-created weight and balance calculation for the flight was not available.

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

Meteorological information

Weather received by pilot

Before departing from CYMA, the pilot did not contact NAV CANADA to obtain a weather briefing from a specialist. The investigation was unable to determine what weather information the pilot had obtained.

Environment and Climate Change Canada meteorological assessment

The TSB requested a weather analysis for the location and time of the accident. The analysis examined the available information and concluded that on the morning of 6 August 2019, a surface trough, associated with a low-pressure system, was located over north-central Y.T. Extensive cumulus and stratocumulus cloud was associated with the trough in the area of the accident along with embedded convective cloud, towering cumulus (TCU), and light rain showers. Westerly winds were predominant across the Y.T. due to the pressure gradient.

At around 11:01, the time of departure from Rau Strip, there were broken to overcast clouds with a light westerly wind of approximately 10 kt. Cloud bases were likely between 4 000 to 5 000 ft AGL, with scattered lower cloud near 2 500 ft AGL. Once the aircraft entered the box canyon, clouds would have likely obscured the mountain tops because Mount Albert’s summit is 6 200 ft ASL. Embedded TCU clouds in the area could have lowered the ceilings to mainly marginal VFR and possible instrument flight rules (IFR) conditions, as observed at Dawson City Airport, Y.T. There were no aviation routine weather reports of marginal VFR or IFR visibilities in the area, although these visibilities could have been possible directly under a rain shower or in the cloud.

Westerly winds could have been stronger than observed due to a potential gap-wind effect as they passed through the canyon. The result could have triggered light to moderate mechanical turbulence in the area. Furthermore, TCU cells typically produce moderate convective updrafts and/or downdrafts, which could have added to the variability of winds experienced during the flight, and further complicated the wind profile through the atmosphere.

Aids to navigation

Garmin GTN 750 multi-function display

The Garmin GTN 750 multi-function display was approved by Transport Canada for IFR and VFR operations and featured a wide area augmentation system (WAAS)–enabled GPS for approaches. An integral part of the system is a moving map display, which depicts the aircraft position relative to terrain. This unit also included the optional Class B terrain awareness and warning system (TAWS), also known as TAWS-B.

The TAWS-B of the GTN 750 is designed to increase situational awareness and help reduce controlled flight into terrain (CFIT) occurrences. The system, also known as forward-looking terrain avoidance, uses GPS horizontal position and altitude information to compare against the terrain database. This allows the system to issue both visual and aural alerts for terrain well ahead o f the aircraft's current position.

The system displays visual and aural terrain alerts to the pilot in several ways. There are threat location indicators on the display that colour the terrain yellow when the terrain is between 1 000 and 100 ft below the aircraft (Figure 3). This is accompanied by a visual annunciation of TERRAIN on the lower left corner of the display and an accompanying aural message of "terrain ahead; terrain ahead." Terrain is depicted red when the terrain is above the aircraft or less than 100 ft below the aircraft's GPS altitude. This is accompanied by a visual annunciation of PULL-UP and an aural message of "terrain ahead, pull up; terrain ahead, pull up" (Figure 4).

The GTN 750 unit was recovered from the wreckage. It was configured for the aural alerts to be active and the system audio level of alerts was set to 25 percent. These aural alerts were available through the intercom system to the pilot's headset.

Additionally, there is a "terrain inhibit" switch on the TAWS annunciator control unit in the pilot's instrument panel to allow the pilot to silence the aural TAWS alerts as desired. When flying VFR in mountainous terrain, it was not unusual for flight crew to inhibit the alerts because they would sound often and could be distracting.

Figure 3. GTN 750 simulator display of terrain depiction based on GPS data entering Granite Creek at 4 000 ft ASL. Magenta line is direct track between Rau Strip and CYMA (Source: Garmin, with TSB annotations)

Figure 4. GTN 750 simulator display of terrain warning based on GPS data about 90 s before impact at 4 000 ft ASL (Source: Garmin, with TSB annotations)

The nature of the impact prevented the investigation from determining the position of this switch before impact.

Wreckage and impact information

The wreckage was located on a rocky mountain slope on a bearing of 340° true (T), 25 NM from CYMA. The aircraft had impacted a 30–40° rocky slope in a slightly nose-up, wings-level attitude at moderate speed, causing the wings to detach and destroying the aircraft. The wreckage trail was approximately 300 ft long, oriented on a heading of 180° magnetic (M) (Figure 5).

All major aircraft structural components were accounted for during the on-site examination of the wreckage. To the degree possible, continuity of primary flight controls was established. The wing flaps were found in the up position.

Survival aspects

The accident was not survivable due to the impact forces.

Organizational and management information

The company operates both 7-days-a-week charter and air ambulance (MEDEVAC) services. The Whitehorse base and the Mayo base, which is seasonal, generally focus on wheel and floatplane charter and MEDEVAC services in northern and western Canada and Alaska.

Operational control

Flight operations out of the Mayo base use a Type C operational control system, which delegates operational control to the captain of a flight. The responsibility for the day-to-day conduct of flight operations is retained by the operations manager.

Figure 5. Aircraft wreckage, looking south (Source: TSB)

Before each flight for day VFR operations, the captain is responsible for filing a flight plan or flight itinerary with NAV CANADA, or for leaving a flight itinerary with a responsible person. In this occurrence, only a flight itinerary was created and filed with the company for the flights of the day. For IFR or night VFR flights, a qualified and knowledgeable person shall be on duty or available; this person is known as a flight follower. Day VFR flights that originate and terminate on the same calendar day and at the same aerodrome, such as the accident flight, are tracked on the company's automated flight-following system.

The automated flight-following system consists of satellite-tracking technology on the ground and in the aircraft. The system records and transmits the aircraft's position every 10 min and also sends an e-mail to company management when the aircraft takes off or lands, or when the emergency switch on the unit is activated.

When the accident occurred, the automatic flight-following system showed that the aircraft was in flight, and, as a result, the company was not aware of the accident until it was notified by NAV CANADA.

Crew resource management and pilot decision making

The objective of crew resource management (CRM) is to reduce human error in aviation. CRM is widely accepted as an effective use of all human, hardware, and information resources available to the flight crew to ensure safe and efficient flight operations.

For single-pilot operations, the concepts are largely the same. The company provided training on the general concepts of CRM and pilot decision making for single-crew operations. The pilot completed this self-study course in December 2017.

At the time of the accident, there were no requirements for CRM training for operations under *Canadian Aviation Regulations* (CARs) Subpart 703. As of 30 September 2019, Transport Canada requires that an operator provide CRM training to flight crews.

Controlled–flight-into-terrain training

Transport Canada standards require companies operating under CARs Subpart 703 and conducting IFR or night VFR flights to provide training on the avoidance of CFIT. This training is to consist of:

- factors that may lead to CFIT accidents and incidents;
- operational characteristics, capabilities, and limitations of ground proximity warning systems if applicable;
- CFIT prevention strategies;
- methods of improving situational awareness; and
- escape manoeuvre techniques and profiles applicable to the airplane type.

The company training program met this requirement.

Pilot decision making

Pilot decision making (PDM) is a cognitive process to select a course of action among alternatives, which involves identifying and evaluating options. PDM typically consists of gathering information, processing information, making a decision, acting on that decision, and evaluating the outcome of that decision against what was expected.

After encountering low ceilings and visibilities on the inbound flight to Rau Strip, the pilot had several options to consider before his departure for CYMA:

- obtain more weather information from NAV CANADA or pilot weather reports (PIREPs) from other company pilots or company dispatch;
- confer with other company pilots on options to consider;
- delay the departure;
- plan an alternate route to CYMA; or
- consider and prepare for entering IMC and completing the flight under IFR as an emergency response to encountering decreasing cloud ceilings and reduced visibilities.

Several factors or biases can, invariably or unconsciously on the part of the pilot, affect PDM. In flight, PDM occurs in a dynamic environment, and it can occur in situations when time is limited.

Pilots operate in a complex environment where there are multiple sources and types of information to monitor. Organizing and simplifying information lessens the burden on their information-processing capacity. Although such information management can aid performance in some conditions, it can sometimes result in strong performance biases that lead to unsafe decisions and a reduced probability of recognizing such decisions.

An example of a decision-making bias is the availability heuristic.[1] This focuses on the timing of an experience, "in that more recent events or conditions in the world generally are recalled more easily." This means that a pilot may make a decision based on a more recent experience: for example, basing the decision to depart from Rau Strip on the success of the previous leg from CYMA to Rau Strip.

Even if an individual makes an initial assumption during a decision, they can always double-check the available information to ensure they have considered all facts. Typically, the more uncertain the individual is, the more information they are likely to seek. However, "if one is more confident than is warranted in the correctness of one's hypothesis, then one will not be likely to seek additional information."[2] This is known as the overconfidence bias.

Once a decision has been made, an individual may then bias all subsequent beliefs in favour of that initial decision (anchoring heuristic) and/or actively seek information and cues that confirm that decision, while also discounting those that support an opposite conclusion (confirmation bias).[3] As a result, "the false hypothesis can be extremely resistant to correction," especially when expectancy is high and when attention is diverted

[1] *A. Tversky and D. Kahneman, "Judgment Under Uncertainty: Heuristics and biases,"* Science, *Vol. 185, Issue 4157 (27 September 1974), pp. 1124–1131, as quoted in C. D. Wickens and J. G. Hollands,* Engineering Psychology and Human Performance, *3rd Edition (Prentice Hall, 1999), Chapter 8: Decision Making, pp. 308–309.*

[2] *C. D. Wickens and J. G. Hollands,* Engineering Psychology and Human Performance, *3rd Edition (Prentice Hall, 1999), Chapter 8: Decision Making, p. 310.*

[3] *Ibid., p. 312.*

elsewhere in the flight, for example to other flight condition threats.[5] The anchoring heuristic relates to the recency effect observed in working memory. In the presence of complex information, the recency effect will have predominance.[6]

Once a pilot has reached a hypothesis about a certain situation, this will form the basis of their mental model of that situation as they proceed with the flight. Once the decision to proceed with the flight has been made, a pilot may then be at risk of plan continuation bias, which is a form of confirmation bias, a "deep-rooted tendency of individuals to continue their original plan of action even when changing circumstances require a new plan."[7] Resistance to changing the plan may be affected by factors such as the perceived loss or gain from changing the plan. Research[8] shows that in flight environments, the framing of a decision in terms of loss or gain of potential outcomes may be affected by the proximity of a pilot's goals, such as the destination airport. As goal achievement gets closer, there may be a natural shift to the "loss" frame, i.e., changing the plan becomes more negative, resulting in an increased motivation to continue with the original plan.

When focusing on a task, individuals generally seek the most meaningful information needed at that time, fixating on the cues deemed critical, often overlooking other available cues. This is a phenomenon known as perceptual bias.[9] As workload increases, narrowing or tunnelling of visual and auditory attention may also occur,[10] exacerbating any perceptual bias.

Flying at low altitude and/or in low visibility

Transport Canada identified that the most critical element in avoiding a collision with terrain in low-altitude flying is time. With more time, a pilot has the ability to:

- identify the obstacle as a hazard;
- select the appropriate action;
- make control inputs; and
- have the aircraft respond.

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[5] *R. D. Campbell and M. Bagshaw,* Human Performance and Limitations in Aviation, *3rd Edition (Wiley, 2002), Chapter 6: Human Error and Reliability, p. 118.*

[6] *C. D. Wickens and J. G. Hollands,* Engineering Psychology and Human Performance, *3rd Edition (Prentice Hall, 1999), Chapter 8: Decision Making, p. 311.*

[7] *B. A. Berman and R. K. Dismukes, "Pressing the approach," Flight Safety Foundation,* Aviation Safety World *(December 2006), pp. 28–33.*

[8] *D. O'Hare and T. Smitheram, "Pressing on: into deteriorating weather conditions: An application of behavioral decision theory to pilot decision making,"* International Journal of Aviation Psychology*, Vol. 5, No. 4 (1995), pp. 351-370.*

[9] *F. H. Allport,* Theories of Perception and the Concept of Structure *(Wiley, 1955).*

[10] *C. D. Wickens and J. G. Hollands,* Engineering Psychology and Human Performance, *3rd Edition (Prentice Hall, 1999), Chapter 12: Stress and Human Error, pp. 483–484.*

The two elements that will dictate the amount of time available to pilots who are flying at low altitude are ground speed and flight visibility.

In this occurrence, the flight visibility was estimated to have been approximately 1 statute mile (SM) and the aircraft was travelling over the ground at about 156 kt or 264 ft per s. This would give the pilot approximately 20 s to understand the aircraft's position relative to obstacles and the aircraft's overall position along the route of flight for the purposes of navigation.

At a constant ground speed of 150 kt, an aircraft would need a diameter of 4 004 ft to complete a 180° turn at a 45° angle of bank, and it would take 25 s to complete the manoeuvre.

At a constant ground speed of 90 kt, an aircraft would need a turn diameter of 1 441 ft at a 45° angle of bank and 15 s to complete the course reversal (Figure 6).

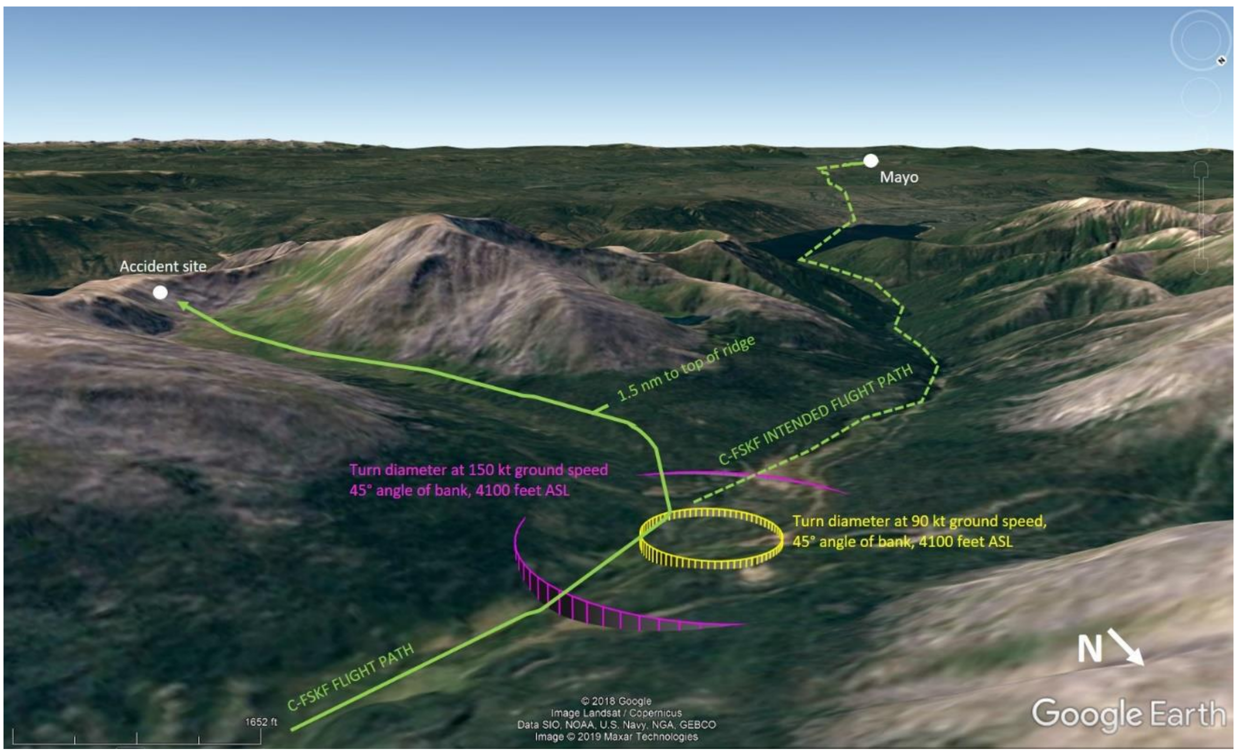

Figure 6. Comparison of turn diameters at various ground speeds in Granite Creek (Source: Google Earth, with TSB annotations)

With an estimated weight of 6 800 lbs, the atmospheric conditions at the time of the accident, and assuming zero wind, the aircraft would produce a climb gradient to clear the ridge of the box canyon if a cruise climb (115 knots indicated airspeed [KIAS], flaps up) was started approximately 2 NM before the accident site.

At the best angle-of-climb speed (74 KIAS, flaps up) the climb gradient would result in clearing the ridge by starting a climb 1.2 NM before the ridge.

Analysis

Introduction

The investigation did not find any technical issues with the aircraft that would have contributed to the accident.

Weather

The weather encountered during the late morning on 6 August 2019 was consistent with the forecast for the area.

The pilot was not allowed to fly if the visibility was less than 5 SM and the cloud height was below 2 000 ft AGL. The hourly weather and forecast weather in Mayo never went below the weather restrictions placed on the pilot; however, the weather encountered along the route from CYMA to Rau Strip was less than those restrictions.

Pre-flight risk assessment

The company began a program a few weeks before the accident that required pilots to perform a risk assessment before each takeoff from CYMA to the various remote strips to which they fly.

The investigation found several prepopulated risk-assessment worksheets for Rau Strip. Since these had already been completed, pilots may not have always been going through the worksheets as intended.

Although this risk-assessment tool has the potential to be an effective safety defence, its use had not matured at the time of the occurrence because it had been introduced only several weeks earlier. Using a prepopulated worksheet would likely decrease the effectiveness of an assessment. If administrative safety defences are not used as intended, there is an increased risk that the hazards associated with the flight will not be identified and mitigated.

Pilot decision making

This was the pilot’s first assignment as a captain in a challenging operational environment: conducting single-pilot VFR operations in mountainous terrain to remote unprepared strips. The pilot’s above-average performance during training and the company’s confidence in the pilot’s ability to perform this type of flying suggests that he had a significant level of confidence and optimism.

The company recognized the hazards associated with these types of operations and provided training that exceeded what was required by regulation to ensure that the pilot was competent for the operation. In addition, weather restrictions were placed on the pilot to ensure that he did not get into a situation where weather would be problematic.

The decision to depart from Rau Strip for CYMA was influenced by several factors. Because the pilot had recently completed the flight from CYMA to Rau Strip, his decision making would have been affected by his familiarity with the route and, consequently, he likely did not consider an alternate route or discuss it with senior pilots. Once he was airborne en route to CYMA, plan continuation bias and confidence would have further affected his decision making with respect to taking action in altering his route when confronted, once again, with the low visibilities and cloud ceilings.

Once the pilot entered Granite Creek and began to fly even closer to the treetops, his cognitive workload would have increased significantly. As the pilot became task-saturated, a narrowing of visual and auditory attention occurred. This perceptual bias would have taken effect as the pilot focused on the task of flying. This likely resulted in the pilot choosing the most meaningful information by fixating on the cues deemed critical and perhaps overlooking other available cues, which could have prompted actions, such as reducing aircraft speed, selecting an escape route, and interpreting his location accurately.

The pilot's decision making was influenced by several biases and, as a result, the flight departed and subsequently continued into poor weather conditions in mountainous terrain.

Alternatives when encountering low visibility in mountainous terrain

The pilot was trained to fly the aircraft in IMC and the aircraft was equipped to do so. Encountering low clouds and reduced visibility in a VFR operation in mountainous terrain can be considered an emergency. One option available to pilots is to climb into cloud to a safe altitude.

In this occurrence, the pilot held a valid instrument rating and the aircraft was equipped to fly in IMC. However, there was no record of the pilot transitioning from a VFR flight to an IFR flight in an emergency in his flying history on the Cessna 208B Grand Caravan or in his training.

Navigation

Shortly after departure from Rau Strip, the pilot began encountering cloud ceilings, which required him to fly, at times, as low as 100 to 200 ft above terrain and in visibilities that were likely as low as 1 SM. The GPS track data showed that the aircraft remained at the cruise airspeed of 156 kt. At no time did the pilot configure the aircraft for operations in reduced visibility by setting the flaps to 20° and reducing the airspeed to 90 KIAS, as indicated in company procedures. The high speed at low altitude and low forward visibility reduced the opportunities for the pilot to take alternative action to avoid terrain.

When flying at low altitude, pilots direct a significant portion of their attention outside the aircraft to avoid striking trees. This was likely the case in this occurrence just before the aircraft turned south into the box canyon, where it was observed at near treetop level.

In addition, when pilots direct their attention outside the aircraft, it reduces their ability to refer to paper maps and to the moving map display. Therefore, their primary awareness of the aircraft's location is based on their recollection of their last known position, especially when they are in a valley or canyon. This recollection can also be compromised when they are flying at a lower altitude than they are used to and in reduced visibility.

The previous flights recorded on the GPS did not include the occurrence route at this altitude. Therefore, this was most likely the pilot's first experience, as captain in the Grand Caravan, in significantly reduced visibility and low-altitude flying in the area.

The pilot turned into the box canyon likely believing that it was the continuation of Granite Creek as it turned to the south, toward the west end of Mayo Lake. The GPS did not record a change of altitude that would suggest the pilot was trying to perform a best angle-of-climb manoeuvre to clear the ridge of the box canyon. Instead, there was a slight increase in altitude that followed the initial gradual elevation terrain in the box canyon.

Within the box canyon, the canyon floor elevation increased abruptly within less than 1 NM and the low visibility prevented the pilot from detecting this increase and taking sufficient actions to prevent collision with terrain.

Terrain awareness and warning system

The Garmin GTN 750 installed in the occurrence aircraft featured Class B TAWS software that could warn a pilot of terrain that may come into conflict with the current flight path. These alert features were designed for situations where most of the flight would be well above terrain.

When pilots are flying in mountainous terrain at low level, the terrain cautions and warnings are near-continuous. As a result, the aircraft is equipped with a "terrain inhibit" switch that can silence the aural alerts. In this occurrence, the TAWS-B would have been providing alerts to the pilot during significant portions of the occurrence flight. To prevent distraction from these aural alerts, the pilot may have silenced them.

When the pilot turned into the box canyon, the TAWS-B aural alerts were ineffective in warning him about the rising terrain either because he had already heard multiple similar alerts in the preceding minutes or because he had silenced the alerts.

Findings

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. The pilot's decision making was influenced by several biases and, as a result, the flight departed and subsequently continued into poor weather conditions in mountainous terrain.
2. The high speed at low altitude and low forward visibility reduced the opportunities for the pilot to take alternative action to avoid terrain.
3. Within the box canyon, the canyon floor elevation increased abruptly within less than 1 NM and the low visibility prevented the pilot from detecting this and taking sufficient actions to prevent collision with terrain.
4. When the pilot turned into the box canyon, the TAWS aural alerts were ineffective in warning him about the rising terrain either because he had already heard multiple similar alerts in the preceding minutes or because he had silenced the alerts.

TSB Final Report A20Q0023—Collision with power lines

History of the flight

At approximately 18:27 on 17 February 2020, a privately registered Cessna 150M, with a passenger seated on the right and the pilot seated on the left, took off from the Montréal/St-Lazare Aerodrome (CST3), Quebec, for a night flight under visual flight rules (VFR). At approximately 18:30, the aircraft conducted an approach to Runway 07 at the Montréal/Les Cèdres Aerodrome (CSS3), Quebec, followed by a pull-up. The aircraft then conducted a 180-degree turn over the interchange between Highway 20 and Highway 30 and flew westbound over Highway 20 at a very low altitude (Figure 1).

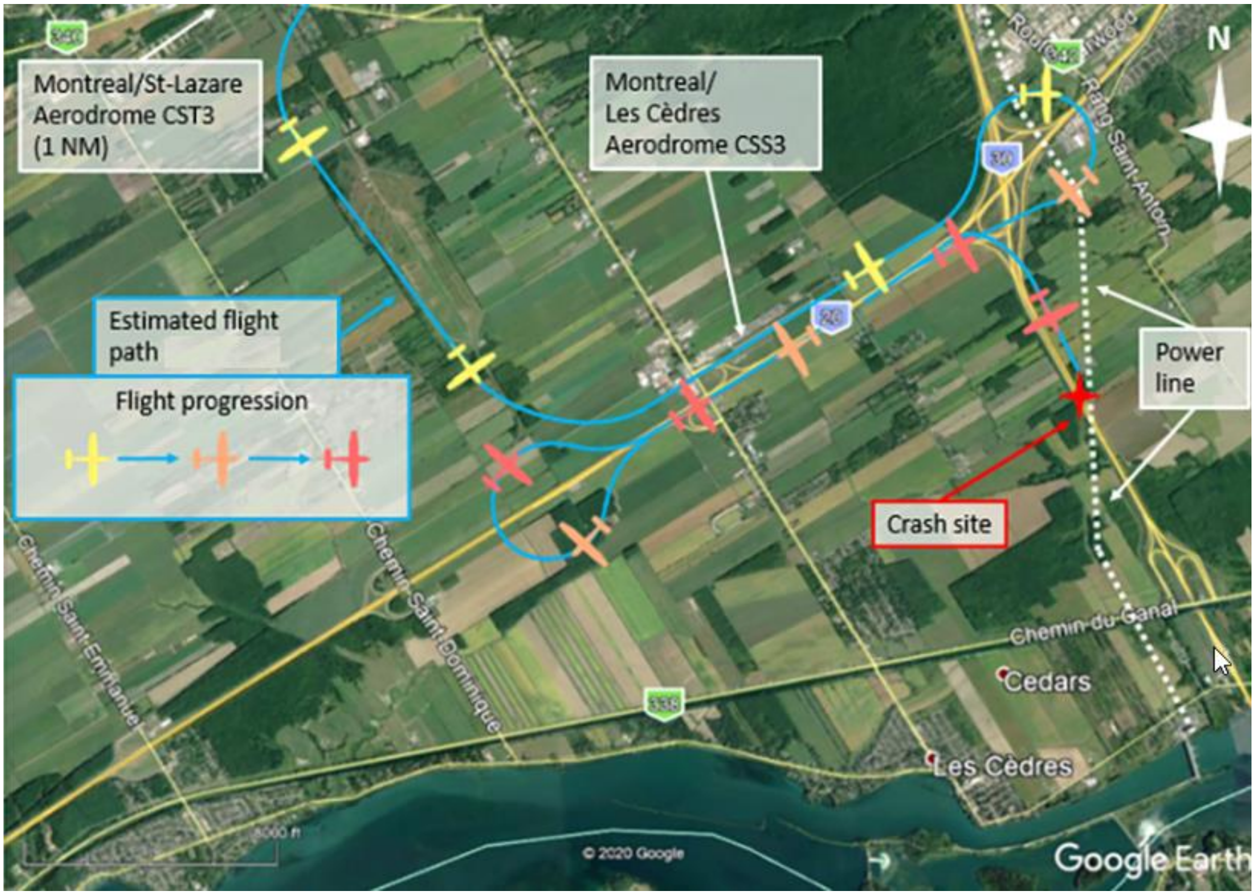

Figure 1. Estimated path of the occurrence aircraft (Source: Google Earth, with TSB annotations)

At approximately 18:34, the aircraft conducted another 180-degree turn, flying eastbound over Highway 20 at a very low altitude. When it was close to the interchange between Highway 20 and Highway 30, the aircraft turned south and flew over Highway 30, still at a very low altitude. At approximately 18:36, the aircraft struck power lines crossing Highway 30 at kilometer 7 and crashed to the ground. The two occupants received fatal injuries. The aircraft was destroyed. Numerous calls were made to 911 by individuals who witnessed the accident. Emergency services arrived quickly at the scene of the accident.

Weather information

According to the aerodrome routine meteorological report (METAR) issued at 18:00 for the Montréal/Pierre Elliott Trudeau Intl. Airport (CYUL), Quebec, 14 NM northeast of the accident site, the weather was favourable for this VFR flight and was not considered to have contributed to the accident.

Pilot information

The pilot had a student pilot permit–aeroplane, issued 23 August 2017, and a valid Category 3 medical certificate. The pilot began initial training in 2017 and acquired the occurrence aircraft in October 2017. According to Transport Canada Civil Aviation (TCCA) records, the pilot’s training was never completed and no further requests were added to his file.

According to the *Canadian Aviation Regulations* (CARs), a student pilot permit allows the holder to act as pilot-in-command if the following conditions are met:

1. the flight is conducted for the purpose of the holder's flight training;
2. the flight is conducted in Canada;
3. the flight is conducted under day VFR;
4. the flight is conducted under the direction and supervision of a person qualified to provide training toward the permit, licence or rating for which the pilot-in-command experience is required; and
5. no passenger is carried on board.

The occurrence flight did not comply with the privileges conferred on a student pilot permit.

The passenger held a valid private pilot licence–aeroplane, issued in September 2015, and a valid Category 1 medical certificate. The passenger also held a night endorsement. However, the investigation determined that the passenger was not at the controls of the aircraft in the moments before the accident.

Aircraft information

The occurrence aircraft was manufactured in 1976. It was certified, equipped and maintained in accordance with regulations in effect.

The aircraft had no known deficiencies before the flight. The aircraft did not have a recorder on board, and regulations in effect did not require that it have one.

Figure 2. Occurrence aircraft (Source: previous owner)

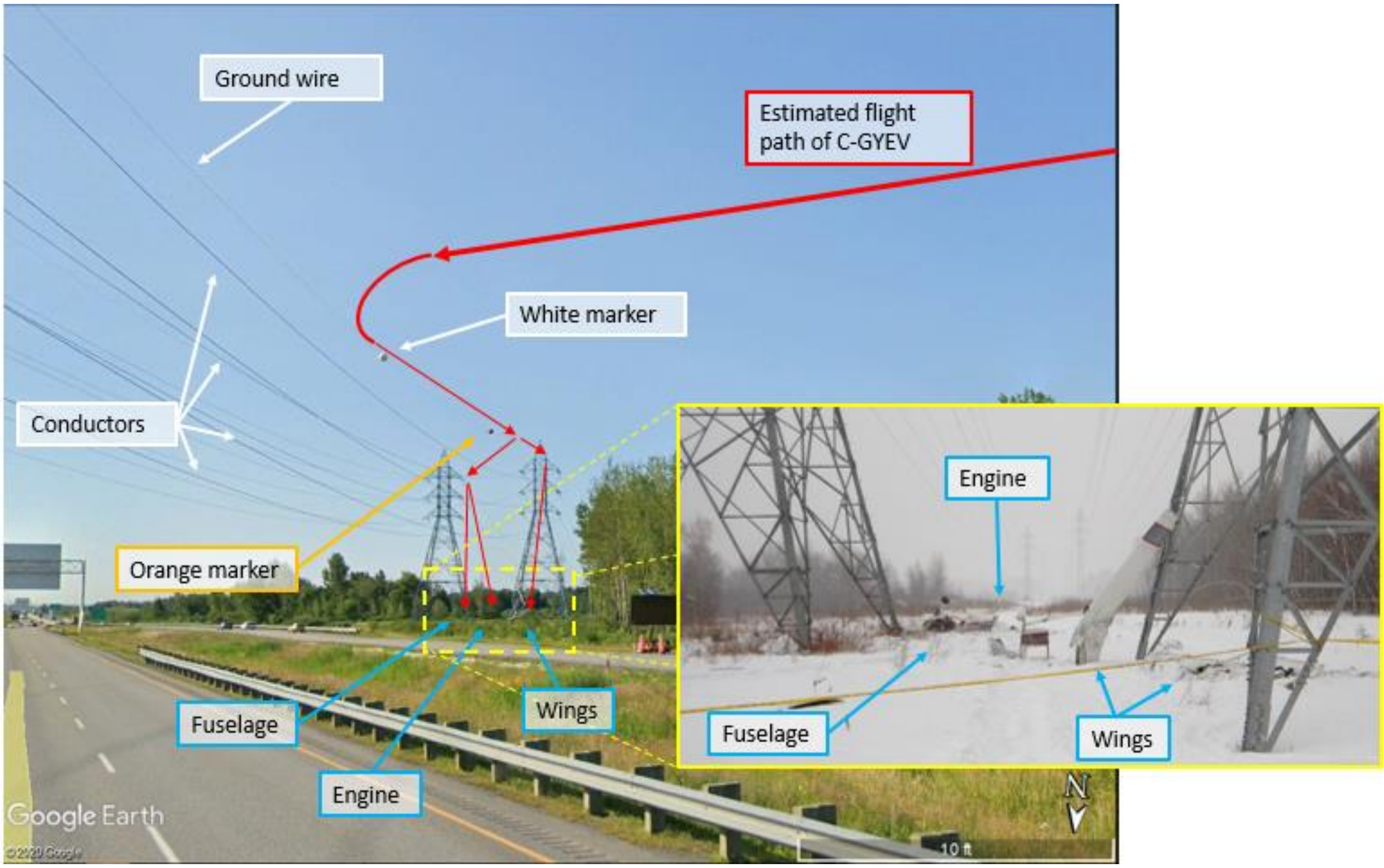

Figure 3. Estimated path of the occurrence aircraft and inset picture of the crash site (Source of main image: Google Earth, with TSB annotations. Source of inset image: TSB)

Accident site and examination of wreckage

The accident occurred at kilometer 7 on Highway 30, where two parallel power lines, installed approximately 21.5 m (70 feet) from each other, cross the highway. These two power lines, which were struck by the aircraft, are operated by Hydro-Québec. The 1st point of impact was the power line ground wire on the west side. This wire extends over the highway at a height no greater than 30 m (98 feet).

Impact marks on the tip of the aircraft's left wing revealed that the initial impact occurred with a (white) marker installed on the ground wire. The dent in the wing observed between the wing strut and the cabin door led to the conclusion that following this 1st impact, the aircraft continued on its path, with the left wing sliding laterally along the ground wire and striking a 2nd (orange) marker, 75 m (246 feet) further.

As the aircraft continued to slide along the ground wire, the wire spliced the roof, which separated from the rest of the aircraft, and the aircraft broke into two parts:

- a part with the two wings, which continued along the ground wire until it struck the hydro tower 75 m (246 feet) beyond the orange marker and crashed to the ground;
- the rest of the aircraft (roofless fuselage), which was thrown more than 14 m (46 feet) further on the power line conductor on the east side, before striking the tower on this line.

When the roofless fuselage struck the hydro tower, it separated into two other parts:

- the rear part of the fuselage and cabin, which struck the ground near the base of the hydro tower;
- the engine (nose of the aircraft), which struck the ground a bit further, bounced, then came to a rest on the ground.

Figure 3 shows the aircraft's estimated path, as well as the markers and wires that were struck. It also provides an image of the crash site and wreckage.

The damage sustained by the propeller, and the damage to the power lines indicate that the engine was producing power at the time of impact. Furthermore, the investigation determined that the power lever was in the full power position at the time of the impact.The power lines that the occurrence aircraft struck were indicated on the Montréal VFR navigation chart (VNC). In general, power lines are indicated on VNCs because they are useful markers that can facilitate visual navigation. The investigation was unable to determine whether the pilot had the Montréal VNC on hand or if he had consulted it before departure.

Marking of obstacles to air navigation

According to CARs subsection 601.24 (2), marking and lighting are required for any building, structure or object that constitutes an obstacle to air navigation. The hydro towers at this location were no higher than 40 m (131 feet) above ground level (AGL) and the wires were lower than the top of the towers. Although they were within a 6 km radius of CSS3, they were not an obstacle according to CARs,[1] given that their height did not exceed 90 m (296 feet) AGL.

Even though the CARs did not require marking at this location, the ground wire crossing Highway 30 was marked, but not lit. The markers had been installed at the request of a fuel company that had an underground pipeline passing through this location and performed day inspections by helicopter.

Low altitude flight

Intentionally flying at a low altitude increases the risk of an accident. The pilot's field of vision is reduced at low altitude. Consequently, the pilot has less time to take action to avoid obstacles and terrain. It is also recognized that flying at low altitude reduces the margin of safety in the event of engine failure, a loss of control or any other unexpected circumstances, while increasing the risk of an impact with the ground or an obstacle.

The CARs stipulates that no person shall operate an aircraft "at a distance less than 500 feet from any person, vessel, vehicle or structure."[2] This distance of 500 feet applies both vertically and horizontally.

Pursuant to the CARs, "[n]o person shall operate an aircraft in such a reckless or negligent manner as to endanger or be likely to endanger the life or property of any person."[3]

[1] *Transport Canada, SOR/96-433,* Canadian Aviation Regulations, *section 601.23.*

[2] *Ibid., paragraph 602.14(2)(b).*

[3] *Ibid., section 602.01.1*

The TSB has recently investigated several occurrences for which this manoeuvre was identified as a contributing factor.

Night flight

Night VFR flights expose pilots to a greater risk of an accident than day flights. The lower number of visual markers, combined with a reduced ability to see at night, makes it difficult to identify the terrain and obstacles to navigation.

Visual performance by the human eye is considerably reduced when lighting is poor.

The human eye takes on average 30 minutes to adjust to an environment with low lighting. During this period of adjustment, night vision is reduced. Bright lights can compromise the eye's adjustment to night vision. That is why pilots are advised to maintain the lighting on their instrument panel at a low setting and to not expose themselves to bright lighting just before takeoff. Also, any lighting in the cabin may be reflected in the windshield and interfere with the pilot's visibility while flying.

In this occurrence, the collision with the wires occurred approximately 9 min after takeoff.

Safety messages

The pilot flying in this accident did not have a pilot's licence or a night rating. Pilots who have not completed the training required to obtain a licence may not have acquired the skills or the decision-making abilities needed to safely conduct a flight.

Low altitude flights always present higher risks, and those risks are further increased at night, when visibility is limited. When flying at a low altitude, it is not easy to recognize and avoid obstacles such as wires, which may be extremely difficult to see. Pilots must be aware of these risks and fly within the prescribed limits.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 26 August 2020. It was officially released on 01 September 2020.

Transport Canada announces strengthened requirements for ELTs on aircraft in Canada

Under the previous regulations, Canadian aircraft were required to be equipped with an analog ELT using the 121.5 MHz frequency. The regulatory changes announced by the Minister of Transport, the Honourable Marc Garneau, will require all Canadian aircraft to be equipped with a digital ELT capable of broadcasting simultaneously on frequencies of 406 MHz and 121.5 MHz, with some exceptions.

The amendments apply to Canadian and foreign-registered aircraft operated in Canada, with the exception of gliders, balloons, airships, ultra-light aero planes and gyroplanes. Commercial air operators, foreign aircraft and private operators have one year after the final publication of the amended regulations in *Canada Gazette*, Part II on Nov. 25, 2020, to implement the amendments while recreational operators have five years to comply. △