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AVIATION SAFETY LETTER

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TP 185E

Cover photo: Kenneth Klein
DHC-3T Otter at an outpost camp

Canada

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TIPS AND TOOLS

Return to Flying after COVID

by Bernard Pichette, Transport Canada, General Flight Standards Inspector (retired)

Summer is at our door… and so is FLYING on and off beautiful lakes and scenic rivers. Don't we all want to get out of the house and taste the magical freedom of flying again? There's no better way than on a pair of floats or in an amphibious aircraft, flying over our magnificent northern regions. Whether it's for preparing the lake camp for the summer, organizing great fishing expeditions, setting up the hunting camp for the fall, or just navigating some of our numerous, jaw-dropping views—no matter what the reasons are to get all excited about float flying, you got stung, and you have the urge to get out there to embrace it all. Let's make sure you do it *safely*, for you and your loved ones to fully enjoy this privilege for a whole season.

The last two years were not like most. This year is the year we resurface from COVID lockdowns. There were a lot of short-notice and irregular confinement periods throughout the country. They differed in duration and severity and by provincial regulations, and they affected some of our privileges and our way of life. This summer, one area of great concern to Transport Canada (TC) and the Transportation Safety Board (TSB), as well as to the

Photo submitted by Keith Monroe
Reflection of Mount Ida on Jarvis Lake, Kakwa provincial park BC

Federal Aviation Administration (FAA) and most worldwide authorities where Covid restrictions were abruptly and irregularly applied, is the REAL status of your aircraft, as well as the REAL status of its pilot.

It has been very difficult for many people to regularly access their airplane (and sometimes aircraft maintenance engineer [AME] support) to adequately perform the short- or long-term storage procedures required by aircraft and engine manufacturers. Today, many pilots and owners are faced with similar difficulties in trying to apply the "return to service" maintenance inspections that are required by those same manufacturers. AMEs and technicians are saturated with work, parts might not be easy to access, and everyone is trying to get back to the skies simultaneously to enjoy what they cherish most. It can't all happen at once, and it's not a race. Take the time required to make sure your aircraft and your engine are adequately verified and serviced.

There have been many opportunities for corrosion to take hold in your engine and in the tubular frame sections, and possibly in your fuel system as well, if water gradually accumulated in the tanks and fuel lines all those months. Some manufacturers published special COVID maintenance documentation, with an emphasis on the negative effects the COVID period brought us and the extra verifications to be made. Carry out extra-vigilant inspections. Plastic tubing and wiring could suffer from long-term storage. Make sure to check every bundle and connection for flexibility, damage and wear. Test all your electronic equipment. Verify if your aircraft is listed on airworthiness directives (ADs) and service bulletins (SBs) that were published over the last few months and last year. If so, advise your AME early. Remember, the owner is responsible for all the maintenance to be performed. The AME signs for the job he or she does and is not validating the certificate of airworthiness (CoA). That's the owner's responsibility.

If you fly a Cessna 206 and are not already aware, you might be happy to know there is a new approved supplemental type certificate (STC) for the Canadian-developed "split forward cargo door window." With this modification, the forward cargo door can be opened regardless of the flap settings. It is a valuable timesaver that greatly reduces complications in the unfortunate event of an underwater egress. While on the subject, there are a few providers across the country offering the underwater egress course. While we understand that it might be difficult for some pilots to reach the location of the practical training portion, we strongly recommend that, minimally, you complete the online ground school.

Now that your aircraft is again safe and sound for flight, it's time to see if the pilot is also fully ready. You most likely renewed your medical using Transport Canada online documentation, or through a video with your physician. Are you really fit to fly? If you smoked, ingested or took any form of cannabis in the last 28 days, you are NOT. If it's been a while since you have flown your aircraft, maybe this is a good opportunity to review its performance. How about normal and emergency procedures? Checklists? Do you feel comfortable handling any situation, at any time? For sure, arms and feet should work as expected, but is your mind reacting as sharply as it did before? Did you lose a little of this "ease and comfort" you developed while flying in turbulence, lower ceilings and crosswinds? Are your eyes still sharp enough for navigating using the VFR Navigation Chart (VNC)? Are your documents and software up to date?

Do you still master a well-organized way of preparing your flight from A to B, keeping C and D in your pocket for unexpected malfunctions or issues? Do you always establish and follow a preset personal protective limit for winds, ceilings, visibility, daylight, extra fuel, etc., limits that might change over time, but NEVER during your flight? Those limits allow you to take the best corrective action before you end up in instrument meteorological conditions (IMC), or before you get stuck so low that your floats are skimming the tree-tops, or before getting in areas where you cannot turn around or land anymore, and before you get so low on fuel that you unconsciously risk anything and/or make bad decisions. Not making it to destination is not a failure if it is because you successfully followed your contingency plan when things turned sour. It takes a strong and capable mindset and good leadership to proceed with your safety plan when any of your preset safety limits are reached. Don't be shy to share those limits with your passengers before you go. It helps.

While airborne, always be aware of your surroundings. Approaching destination, take the extra minutes to perform a good scan of your landing area. Are there new towers, cables? Did the trees grow enough that they are a concern on approach, go-around or takeoff? What is the best path for landing and for takeoff? Should I expect crosswinds or turbulence during this approach or climb-out? How about downdrafts? Can I stay clear of those? If the wind changes before I take off again, what will be my best path? Will it provide me with the safety margin required? Is the water level lower than usual? Can I see rocks or underwater obstacles on this pass? How about floating debris?

Flying off water surfaces is one of the most exciting and fun experience possible, providing an unparalleled feeling of freedom when done *safely* and in respect of nature and others. Enjoy your summer. △

How to Recover an Ultralight Aircraft Off-field

by Gordon Dyck and Claude Roy, Ultralight Pilots Association of Canada *(UPAC)*

If you've been involved in an off-field aircraft recovery, you know that getting out of that position involves some unusual people skills. This article will help you understand what happens during the event and how to perform an off-field light aircraft recovery.

Let's start by describing a scenario of what can happen to anyone flying for fun in a light private aircraft on a nice, sunny summer day.

Scenario 1

You are the pilot-in-command and alone aboard your own ultralight. You're flying casually around your own hometown, within view of your own home airport. Suddenly, the engine quits.

Is it a mechanical break?
Some sort of fuel flow problem?
An electrical issue?

Who knows?! The fact is, you're coming down at 500 ft per min, and you need to find a place to land. Forget about going back to the airport; you won't make it.

Ultralights are slow and draggy. They also fly at low altitude, usually around 2,000 ft above ground. A stopped motor usually leaves you three minutes to react and land. That's very little time for any "MAYDAY" radio call, using a checklist, or restarting the engine.

Better to concentrate on your approach. Lucky for you, there's a suitable field nearby and you land in it, dead stick.

Nobody notices you. The landing was good and would have been great if it wasn't for the rough terrain that damaged your landing gear. But you made it in one piece, so you're happy.

After making sure all the switches are off, you review your checklist to make sure you haven't forgotten anything important. You get out of your plane, a little shaken, and you assess the situation, including the need to stop any oil or chemicals that have spilled onto the field.

Scenario 2

In another scenario, let's say you have landed perfectly with no damage. As someone who does their own maintenance, you want to figure out why this engine stopped. You find something, the engine runs up, the field is big enough...

Stop right there. Do not be tempted to fly the aircraft out.

Failures typically occur through a series of faults, and you may have only found one. The field is no place to troubleshoot. It will take time, and it needs to be done in the hangar.

At this point, you can walk out of that field unhurt, but not your airplane. It will have to be carried out.

Credit: Gordon Dyck
Wings are off in the back of pick-up truck

Nobody is coming towards you, so you'll have to look for someone. Expect local police or firefighters to arrive. If they do, most will have zero experience with an off-field aircraft landing.

Be patient and explain what happened so they can write up their incident report. They will have to contact their superiors before they allow you to do anything. Once they have approval, the first responders will head back to work, leaving you by yourself to figure out how to recover your plane.

Recovering the plane: Day 1

Do you have your cell phone with you? Call your airport or the person you filed your flight itinerary/flight plan with and let them know that you're safely on the ground. You could also send the preformatted message on your personal locator beacon.

You now need to find whoever owns the field you're in. You walk to the closest house to your landing field and knock on the door.

The field owner may be there, but chances are you will speak to an intermediary. Make it clear that everything is safe and secure around the airplane, but also that you'll need some help to get your airplane out. Then, return to the plane and further assess the situation.

Then you call your airport friends to figure out how and how soon you can get your airplane out of that field and back into your airport hangar.

Once the field owner arrives, things can get complicated. You are on their property, uninvited and unwanted. For the moment, you are tolerated, a novelty from the usual routine. People are curious about you and how you ended up in that field.

Be very polite with everyone. Listen carefully to everything they say, since you're in a delicate legal position. You'll need the field owner's cooperation to get your airplane out of there.

At first, the owner is relieved you're safe, the airplane is small, and it has so far done little damage to their crops. Tell the owner that you've already called for help, and you expect some friends to come and pick you up for a ride back to your car at the airport. Let them know that you'll be back later in the day with a group of people to assess the situation and will remove the plane from their field.

At this point, the field owner may instruct you on how to remove the plane. Even if it is not quite how you would do it, try to go along with what they say. Remember that it is their field and their crop. There are many good reasons why the owner may have specific instructions for removing the plane.

You're lucky to have three good friends who immediately agree to help you. They don't know where you are or how to get to the plane, so you meet them at the airport. From there, you drive back to the landing site.

Make sure to introduce your friends to the field owner(s) and anyone else who is with them.

Openly discuss and form a plan to remove the airplane. Make sure to decide when and how the work will be done. It will usually involve a vehicle with a flat trailer to remove the aircraft from its current position. Do everything you can to get the field owner to agree to your plan.

Tomorrow's weather will be fair and dry, with light winds. If the forecast is bad, tie the aircraft down with the kit that you keep on board the aircraft or that you brought with you from the hangar. Your three friends confirm they are available to help you dismantle the wings from the aircraft and roll the fuselage to and onto the trailer.

Your day is done. Things are looking better, but you won't get much sleep tonight.

Recovering the plane: Day 2

When you arrive the next morning, let the field owner know that you're starting work right away. Expect to have a few onlookers join in, since watching an aircraft get dismantled is quite a sight. Be friendly and ready to entertain them with your aviation knowledge.

You and your crew need to be self-sufficient. Make sure you bring everything you need, including ground sheets, rope, and packing material. As you work on the plane, make sure not to spill any chemicals, like gas or antifreeze liquid, onto the field.

Onlookers will be watching your level of care around the plane. This is key to getting out of that field with minimal issues.

The wings are now off, and the fuselage is rolled to the trailer. The trailer may be far away, as this can limit the damage to the field. Ideally, you'll want to leave the field looking like you never were there.

You may need two or three trips to the trailer. Two wings are bulky and there may be plenty of obstacles between the airplane and the trailer.

Once the airplane is back in the hangar, take your crew on a final trip to the field to make sure everything is back to its original condition. Make sure you do everything possible so there's no trace of your landing and presence there.

Experience shows that farmers and field owners are good people. Do it right, be polite, and most field owners will let you recover your airplane with few problems.

If they're interested in aviation, even better. People admire a flyer's sense of daring. More often than not, people will want to participate in your adventure rather than hinder it.

Experience also shows that three out of four off-field landing experiences have a happy ending. When that happens, be ready to do something special for the field owner(s), like dropping a bottle of real champagne with a thank-you card, giving them a gift card to their favourite local restaurant, or inviting them for a flight later.

Make sure to thank the friends who helped you and be ready to help if anyone at the airport needs you and your newly minted off-field recovery expertise!

Happy flying! △

INSTRUCTOR'S CORNER

What is Windshear and How Do I Effectively Recover?

by Michael Schuster, Chief Instructor, Aviation Solutions

Windshear is quite simply rapidly changing wind. It could be horizontal *(such as from a low-level jetstream)* or vertical *(such as from convective weather)*. The term windshear literally means a "tearing" of the wind as it changes abruptly.

However, what many pilots cannot easily define is how much tearing is required for windshear to be present. In the Flight Safety Foundation Approach and Landing Accident Reduction Toolkit, Briefing Note 5.4, windshear is defined as unexplained:

- Airspeed deviations of +/- 15 knots or more
- Vertical-speed excursions of 500 fpm or more
- Pitch attitude excursions of 5 degrees or more
- Glideslope deviations of 1 dot or more
- Heading variations of 10 degrees or more
- Unusual power requirements
- Groundspeed variations

The dangers of windshear are well known and the accident list regretfully long. One common theme across many windshear accidents is unfortunately that the crew did not recognize it early enough to carry out an effective recovery.

Recognizing windshear is a critical first step to recovering from it. From personal experience, I've seen many pilots be their own worst enemy and initially mask the windshear event. For example, a pilot may be so focused on flying their target approach speed that they may not notice they have adjusted their pitch attitude or vertical speed significantly in order maintain that airspeed. They may still have the target speed, but the vertical speed has come to zero and the pitch attitude has changed by more than five degrees and, in some cases, they have had to pull the power to idle to do so.

Another "gotcha" is heading variations: many pilots forget that windshear could come from a lateral position such as a thunderstorm cell located on the left or right; that's why heading and groundspeed are in the above list as well. As you climb and descend, you can expect a normal amount of veering or backing of the wind. However, an abrupt change in direction or speed can be an early indicator of windshear. With so many of today's aircraft equipped with advanced avionics and complete GPS packages, monitoring groundspeed should not be cumbersome.

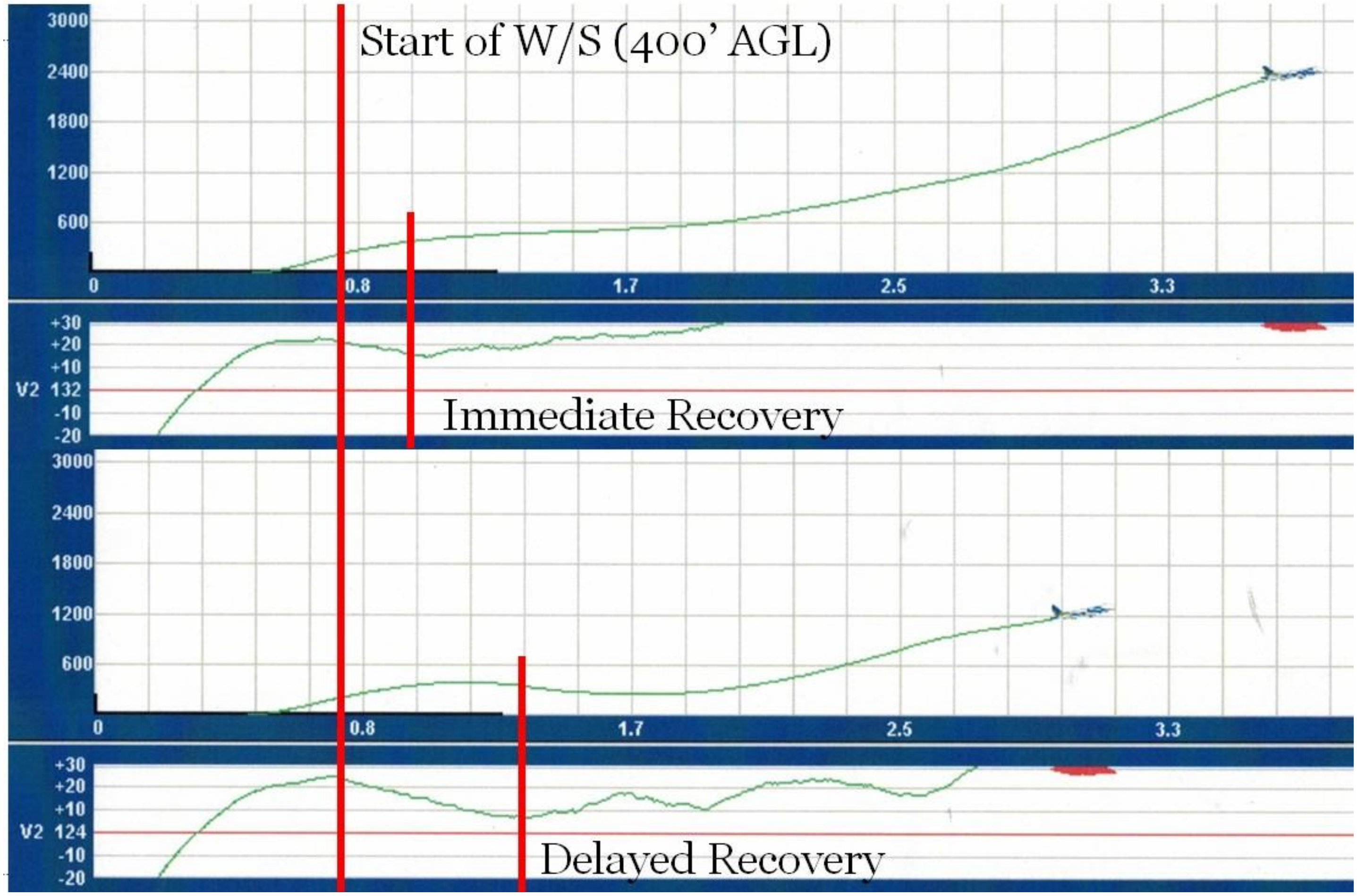
When it comes to recovery, the general rule of thumb (barring any specific directive in the POH/AFM or company standard operating procedures) is to climb away from the ground at the best lift/drag ratio. For smaller aircraft, this is Vy, and for larger aircraft, V2 or Vga.

Credit: iStock

While flying at the correct escape airspeed is important, clearly understanding when you've entered windshear may be even more important. Below are two representative recovery profiles taken from a windshear encounter in a simulator.

In both cases, the performance decreasing shear started as the aircraft was climbing through 400 ft above ground level (AGL). In the first case, the pilot quickly recognized that the aircraft speed should not be decaying and initiated recovery immediately. In the second case, the pilot waited until speed had decayed to nearly V2 before initiating recovery—approximately ½ nautical miles (NM) later along the departure path.

It should be noted that the second pilot flew the recovery more effectively; they were much more accurate at maintaining the target speed of V2. However, the first pilot, even though they flew at V2 +20, didn't get a sink during the manoeuvre like the second pilot did. Why? It may be worth considering the extra energy the aircraft was carrying when the recovery was initiated in Case 1.



Comparative windshear recoveries

Ultimately, both recognition and recovery skills are critical in any windshear encounter. But, as pilots, we may want to increase our focus on improving recognition skills.

A version of this article originally appeared on aviationsolutions.net. *Mike Schuster is an experienced Class 1 flight instructor who has taught at all levels, from ab initio to airline.*
He is the Chief Instructor at Aviation Solutions, which is an authorized Flight Instructor Refresher Course provider for rating renewal. △

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 A19Q0107—Collision with trees

History of the flight

At approximately 1000 on 12 July 2019, a private de Havilland DHC-2 Mk. 1 Beaver floatplane took off from the Saint-Mathias Water Aerodrome (CSV9), Quebec, with only the pilot on board, for a series of visual flight rules (VFR) flights. The aircraft landed at approximately 1130 on Désert Lake in La Minerve, Quebec, and came alongside a private dock where three individuals were waiting to board and fly to a fishing lodge.

Once the baggage was stowed on the aircraft, the pilot provided a safety briefing to the passengers, who were all wearing a personal flotation device. The aircraft took off from Désert Lake at approximately 1215, bound for the Barrage Gouin Water Aerodrome (CTP3), Quebec, where the aircraft was scheduled to be refuelled. The aircraft landed at approximately 1430. Once the refuelling was complete, the aircraft took off once again around 1528 and headed northwest to Weakwaten Lake, Quebec, where the fishing lodge was located.

After approximately 48 minutes of flight, at around 1616, the aircraft collided with trees and struck the ground. The emergency locator transmitter was activated by the force of impact and began transmitting a signal on frequency 121.5 MHz. This signal was detected by the flight crew of a commercial airliner at 1705 and reported to air traffic services. At 1850, the Joint Rescue Coordination Centre in Trenton dispatched a CC130 Hercules aircraft to try to locate the distress signal. The occurrence aircraft was found in a densely wooded area at 2032. Two search and rescue technicians were parachuted to rescue the aircraft occupants. Three of the four occupants received fatal injuries. The survivor was evacuated and transported to the hospital in Chibougamau, Quebec.

Weather information

At 1300, the centre of a quasi-stationary low-pressure system was located approximately 37 statute miles (SM) north of the Roberval Airport (CYRJ), Quebec (Figure 1). Areas to the west and northwest of the low-pressure system were influenced by a cloudy return flow strengthened by high humidity, which was 87% at CTP3 and 100% near the site of the accident. Localized areas of mist, drizzle or intermittent rain were also possible in these areas, which could lead to a reduction in visibility and in the height of the cloud ceiling. Between 1300 and 1700, the Chibougamau/Chapais Airport (CYMT), Quebec, located approximately 43 nautical miles (NM) north of the scene of the accident, reported visibility varying between 2½ SM and 9 SM, with a ceiling at 400 ft above ground level (AGL) and intermittent low precipitation.

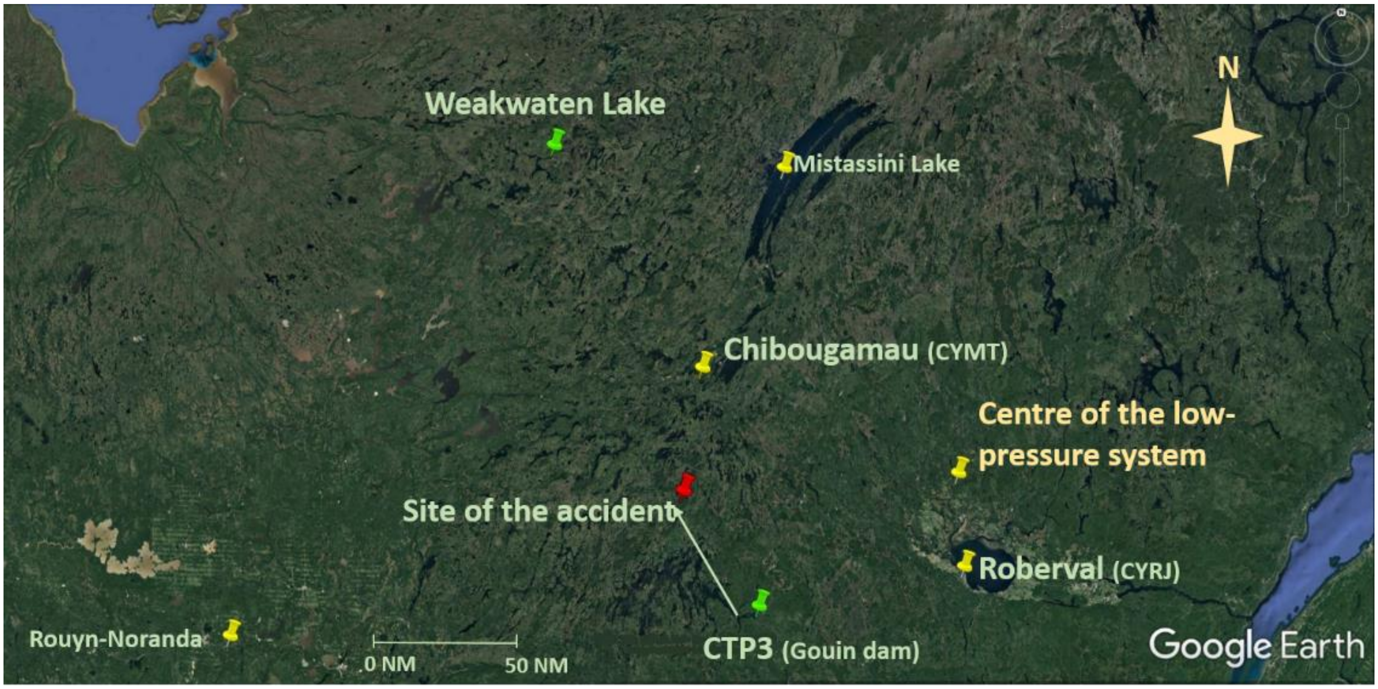


Figure 1. Centre of the low-pressure system in relation to the points of interest in the occurrence (Source: Google Earth, with TSB annotations; map data: Image Landsat/Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO)

Between 1300 and 1700, the cloud base was generally between 400 and 1 200 ft AGL in the areas to the west and northwest of the low-pressure system. Given that the elevation at the site of the accident was higher than that of the weather stations providing the data, it is possible that the cloud ceiling was below 400 ft AGL in some places.

The temperature recorded to the north of the Gouin Reservoir was approximately 14°C. According to the weather analysis, the aircraft did not encounter any icing conditions while in flight. Furthermore, low-level winds were light and no wind shears or turbulence were forecast below 4 500 ft above sea level (ASL).

Pilot information

The pilot held a Private Pilot Licence—Aeroplane, with ratings to operate single-engine aircraft and seaplanes and conduct night flights. He had a valid Category 3 medical certificate. The pilot had accumulated 1 028 hours of flight time in total, including 314 hours on board the DHC-2 Beaver.

The pilot was certified and qualified for the flight in accordance with existing regulations.

Aircraft information

Technical records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations. There was no evidence of an airframe, engine, or system failure during the occurrence flight.

Planning the cross-country flight

Determination of the aircraft’s weight

The trip had initially been scheduled for 11 July. When the trip was being planned, approximately 10 days before departure, a stop at Ledden Lake, next to CYMT, had been included for refuelling purposes. The aircraft’s weight had been calculated, taking into account the baggage and passenger weights provided to the pilot on request. The fuel weight had been determined based on the remaining weight available to achieve the maximum permissible take-off weight of 5 370 lb, as indicated in the current amendment of the aircraft's weight and balance report. However, the investigation was unable to determine how the fuel planned for the flights was distributed among the aircraft's tanks and the six 20 L canisters stowed in the float compartments.

Pre-departure weather checks

The flight on 11 July was delayed until 12 July due to poor weather conditions. At 0904 on the morning of 12 July, the pilot contacted the Québec flight service station (FSS) to obtain a weather forecast. The briefing indicated a low cloud cover due to a humid and unstable air mass associated with the low-pressure system. According to the forecast, the cloud base was going to rise during the morning, in time for the flight to La Minerve. However, as the aircraft got closer to the low-pressure system, the cloud cover density would increase; the ceiling could drop to 800 ft and visibility could be reduced to 2 SM in places due to isolated showers.

The pilot contacted the Québec FSS two more times to track the changing weather conditions. Although no improvements were expected, the decision to conduct the flight was upheld, with an intention to reassess the situation while en route. A flight itinerary was filed with a responsible person and the flight was tracked using the pilot's SPOT satellite personal tracker, brought on board.

Given that the cloud ceiling was low at CYMT, the pilot decided to refuel at CTP3, which extended the distance to the lodge by approximately 85 NM compared with the initial plan.

Refuelling on departure from CTP3

At CTP3, all of the aircraft's tanks were filled, along with the six canisters, which added approximately 300 lb to the total weight of 5 370 lb initially calculated by the pilot. The investigation was unable to determine whether the pilot knowingly accepted this excess weight. The total weight of the aircraft on takeoff from CTP3 was estimated by the TSB to be 5 810 lb. Based on the list provided to the pilot by the passengers, the weight of the baggage, food, and drinks may have been underestimated. Also, some of the items brought on board did not appear on the list provided to the pilot.

After approximately 48 minutes of fuel use, the aircraft's weight at the time of the accident was estimated to be 5 685 lb, which is 315 lb over the maximum permissible take-off weight used by the pilot during flight planning, or 595 lb over the maximum weight specified in the DHC-2 flight manual when the aircraft is equipped with floats.

Review of flight route

The aircraft took off from CTP3 at approximately 1528 heading northwest. The pilot was using the ForeFlight application, installed on a tablet, as a navigation aid. No flight data could be retrieved from the tablet by the specialists at the TSB Engineering Laboratory. However, data were successfully downloaded from the engine data management system that was installed on board the aircraft, which helped to establish that the engine was working properly.

The pilot's SPOT tracker transmitted a signal at 1547 between CTP3 and the accident site, providing the aircraft's global positioning system (GPS) location at that time. According to the data collected during the investigation, the flight path between CTP3 and the accident site seems to have been flown primarily in a straight line. In addition, the time at which the SPOT tracker's signal was transmitted helped to determine the aircraft's various ground speeds between CTP3 and the accident site, and to determine that the aircraft had slowed down before the accident.

Using the aircraft's estimated straight path and comparing the data from the engine data recording and monitoring system, the estimated ground speeds, and the topography, a correlation was found between the use of the power lever and the topography of the terrain (Figure 2). It was also found that the aircraft's altitude in relation to the terrain lessened as the flight progressed.

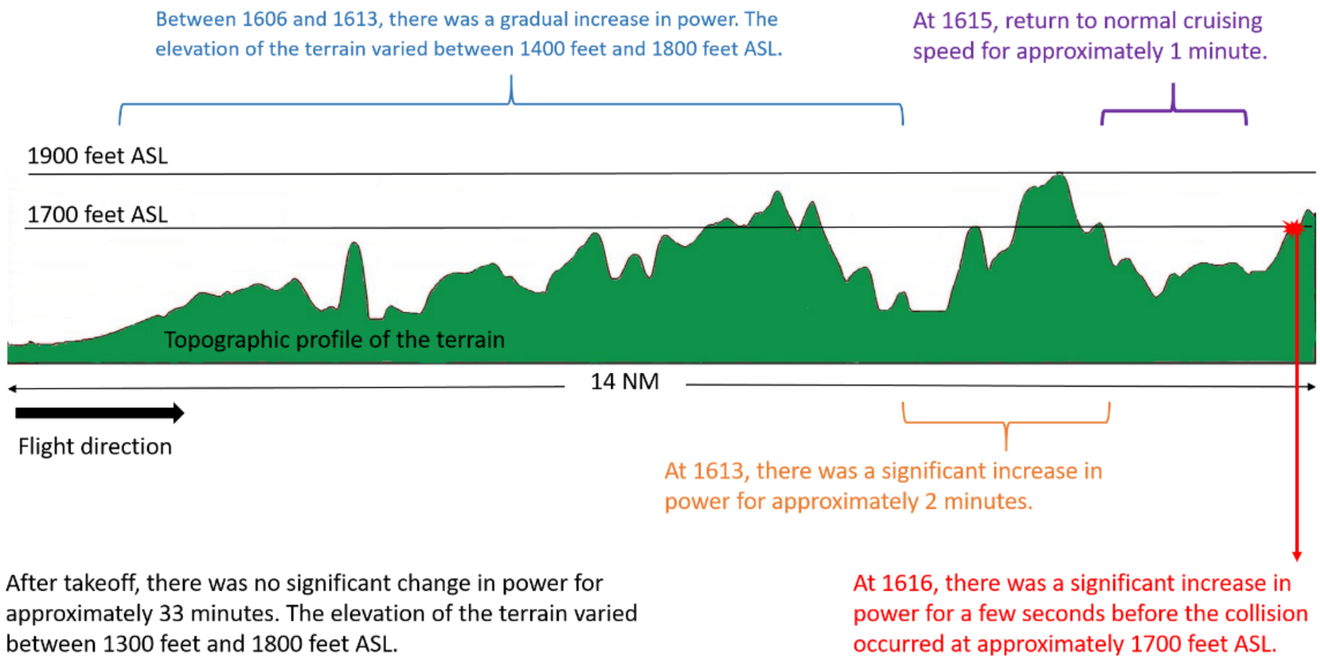


Figure 2. Correlation between the topographic profile of the terrain and power parameters (Source: TSB)

View from the cockpit

Deteriorating weather conditions can force a pilot flying under VFR to reduce altitude to avoid losing all visual contact with the surface. Given that a pilot will tend to reduce speed as the aircraft approaches the ground, the aircraft could end up in slow flight.

Figure 3. Visual references of the attitude from the cockpit (Source: TSB)

In slow flight, the aircraft is more nose-up than it is at cruising speed. The nose-up position changes the position of the horizon visible from the cockpit as well as the earth's surface that is visible (Figure 3). The horizon and the earth's surface are therefore the main visual cues used by a pilot to determine the aircraft's attitude. If a pilot sees the horizon move to the lower part of the windshield and the earth's surface that is visible diminish above the instrument panel, the pilot can recognize the aircraft's nose-up position.

In mountainous terrain, given that the rising terrain often masks all references to the actual horizon, the pilot will have a harder time accurately assessing the aircraft's attitude and altitude if the pilot relies solely on the visual cues without referring to the flight instruments. For example, an incorrect reference to the horizon can create the illusion that the aircraft is in level flight when it is actually descending.

In slow flight, the pilot's front viewing angle is reduced (Figure 4). Also, when the aircraft has a high instrument panel, as is the case in the DHC-2, the reference line for the actual horizon and the terrain may be completely hidden by the instrument panel. Hence, the visual cues needed to detect obstacles straight ahead are greatly reduced, which hinders the pilot's ability to maintain a safe altitude when flying at low altitude, and even more so when visibility is reduced.

In this occurrence, the fact that there was a sudden increase in power a few seconds before the collision with the trees, while the aircraft was possibly descending toward a rising terrain, suggests that the pilot saw the trees too late. The reduced speed, excess weight and proximity of the trees prevented the aircraft from regaining sufficient altitude to avoid the impact.

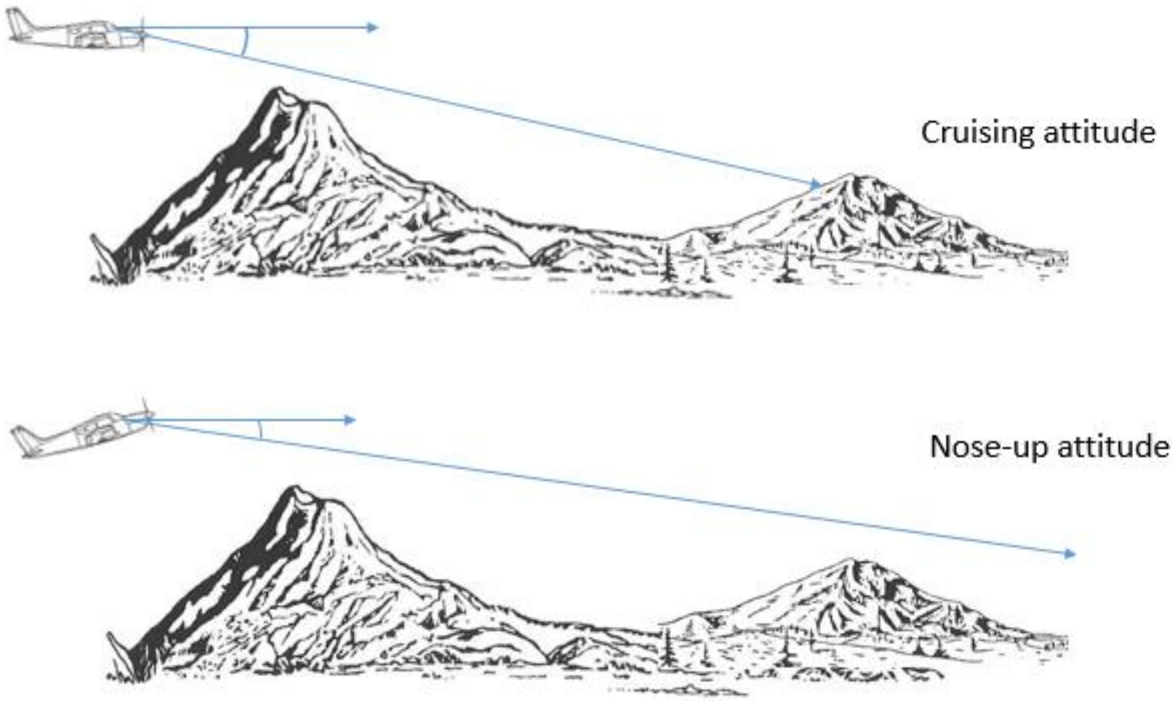


Figure 4. Pilot's viewing angle depending on the flight attitude (Source: TSB, using figures in Transport Canada's Air Command Weather Manual *[TP 9352E] and* Flight Training Manual *[TP 1102E])*

Safety messages

Effective pre-flight planning contributes to mitigating the risks associated with unforeseen circumstances and to deciding in advance on a backup plan, if necessary. Sometimes, however, information that is missing, incorrect, or not reassessed according to the circumstances creates an unsafe situation of which the pilot is unaware, as was the case for the excess weight in the occurrence aircraft.

A flight conducted in a remote area where detailed weather data and fuel are not readily available has additional risks. To minimize these risks, pilots must set clear limits for themselves or their passengers in advance, limits that should provide a margin of safety for the flight and assist pilots in knowing when to implement their backup plan before the margin of safety disappears.

Adverse weather conditions, such as a low cloud ceiling and reduced visibility, may compel a pilot to decrease the flight altitude to maintain visual contact with the ground. When a flight is conducted in a mountainous area at very low altitude, the pilot is quite likely to reduce speed, which will affect the aircraft's attitude. Given that visibility from the cockpit is reduced, the risk of collision with terrain or an obstacle in front of the aircraft will be greater if altitude is insufficient.

TSB Final Report A19O0089—Loss of control and collision with terrain

History of the flight

On 11 July 2019, at 0700, the pilot of the float-equipped de Havilland DHC-2 Mk. I Beaver aircraft began his duty day in anticipation of an 0800 flight departure from the Hawk Junction Water Aerodrome (CNH6), on Hawk Lake, Ontario. He conducted pre-flight preparations and fuelled the aircraft for the charter flight to drop off goods and supplies at a remote camp on Oba Lake, Ontario, approximately 35 nautical miles (NM) north-northeast of CNH6. Due to low overcast cloud, departure was delayed until the weather became suitable for flight under visual flight rules (VFR). At approximately 0840, the pilot and the passenger boarded the aircraft and the pilot started the engine. The take-off direction was toward the northeast, which required taxiing for approximately 10 minutes toward the southwest end of the lake for departure.

At approximately 0852, the aircraft began its take-off run. It became airborne approximately abeam the dock (Figure 1) and climbed to an estimated height of 300 to 400 ft above ground level (AGL). The aircraft was observed to be climbing normally before entering a sudden left bank and an extreme nose-down attitude.

Figure 1. View of occurrence site, with dashed magenta line showing estimated flight path (Source: Google Earth, with TSB annotations)

In the vicinity of the accident site, the sound of the engine was abruptly diminished, as if the engine was suddenly operating at a low engine power setting or was not running. The sound of an aircraft impacting the ground was heard shortly after.

At 0853, the aircraft collided with terrain beside a hydro substation, just outside the town of Hawk Junction. The pilot and passenger were fatally injured. The aircraft was destroyed, but despite a significant amount of fuel leaking, there was no post-impact fire. The emergency locator transmitter (ELT) activated on impact, and the signal was received by the Joint Rescue Coordination Centre in Trenton (Ontario).

Damage to aircraft

The aircraft was destroyed as a result of the collision with terrain.

Other damage

One hydro line was severed by the aircraft's left elevator immediately before the collision with terrain. There was minor damage to the chain link fence enclosing the hydro substation adjacent to the collision site. Hydro service was interrupted to nearby communities for approximately 2 hours.

Aircraft information

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

Weight and balance

The occurrence aircraft's maximum permissible take-off weight was 5 090 lb. The load record for the occurrence flight was found at the site of the accident and indicated a take-off weight of 5 010 lb. Weighing of the cargo items found at the occurrence site suggests that the cargo weight was accurately recorded on the load record.

The investigation was unable to confirm how much fuel had leaked from the aircraft following the occurrence. The load record for the occurrence flight indicated a fuel load of 210 lb (approximately 29 imperial gallons).

Fuel system

The DHC-2 Mk. I aircraft contains three fuel tanks located beneath the cabin floor and designated front, centre, and rear tanks. Fuel is added through individual filler necks located in a compartment with a hinged door on the left side of the fuselage, adjacent to the cockpit door. The front and centre tanks each have a capacity of 29 imperial gallons, while the rear tank has a capacity of 21 imperial gallons.

During normal engine operation, fuel pressure is provided by an engine-driven fuel pump. A wobble pump is used to build up fuel pressure before engine start, or to maintain fuel pressure should the engine-driven fuel pump fail.

Fuel selector

To select a fuel tank in the DHC-2 Mk. I aircraft, the pilot operates a four-position, D-shaped handle selector located on the lower left side of the instrument panel in the cockpit. The handle is shaped in such a way as to function as a pointer, with a raised arrow on the top of the handle, which points to the selected tank (Figure 2).

Figure 2. Fuel selector from the occurrence aircraft, with the rear tank selected (Source: TSB)

The fuel selector positions available are OFF, FRONT TANK, CENTRE TANK, and REAR TANK. The selector cannot be turned clockwise from the REAR TANK position to the OFF position, nor can it be turned counterclockwise from the OFF position to the REAR TANK position.

The fuel selector is connected with cables to the cable-actuated selector valve located in the belly of the aircraft, aft of the rear fuel tank.

The fuel selector was found to be set to the REAR TANK position at the occurrence site, as shown in Figure 2. The cable-actuated selector valve was also found to be positioned for the rear fuel tank to be the fuel source.

Fuel pressure

The DHC-2 Mk. I aircraft is equipped with a fuel pressure indicator located on the engine instrument panel. It is also equipped with a red low-fuel-pressure warning light that is positioned above the flight instrument panel and that illuminates whenever the fuel pressure drops below 3 psi.

An examination of the low-fuel-pressure warning light by the TSB laboratory indicated that the light was illuminated at the moment of impact.

Carburetor icing

Any carbureted aircraft engine is susceptible to carburetor icing under certain atmospheric conditions: high relative humidity (above 80%) and outside air temperatures as high as 20°C. On the day of the occurrence, the air temperature was 14°C, while the dew point was 13°C, which creates the potential for serious carburetor icing. Ice can form inside the carburetor as intake air is cooled by the venturi effect, restricting the flow of air and fuel to the engine. Power loss will result, and if the signs go undetected, a total loss of power can occur. Aircraft use a carburetor heat control to introduce warm air into the carburetor in order to either keep ice from forming or to melt any ice that has already formed. Carburetor heat is not normally used during takeoff because it diminishes engine performance.

Stall characteristics

According to the DHC-2 flight manual, the "stall is gentle at all normal conditions of load and flap and may be anticipated by a slight vibration, which increases as flap is lowered." However, during a stall, "[i]f yaw is permitted, the aircraft has a tendency to roll." The pilot must immediately take corrective action to prevent the roll from developing. The manual also states "[i]n tight turns, flight load factors may reach the limit loads, and may also increase the danger of an unintentional stall."

Stall warning system

Aircraft design standards require that aircraft certified in the normal, utility, aerobatic, and commuter categories be equipped to provide the pilot with a clear and distinctive stall warning, with the flaps and landing gear in any normal position, in straight, and in turning flight. The standards also state that:

"[t]he stall warning may be furnished either through the inherent aerodynamic qualities of the aeroplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself."

Flight tests completed during certification of the DHC-2 type in the 1940s determined that the aerodynamic buffeting near the stall was a clear and distinctive stall warning. As this was deemed to have met the design requirements, no further device or stall warning system was mandated to be installed.

In practice, very few aircraft types still in commercial operation today were type-certified without a stall warning system. The few types remaining in commercial operation, including the DHC-2, were certified before 1960.

Since 1998, the TSB has investigated 14 occurrences (not including this one) involving a de Havilland DHC-2 stalling and crashing, resulting in 38 fatalities.

The occurrence aircraft was not equipped with a stall warning system, nor was it required to be by regulations.

DHC-2 stall warning system modification

Although the occurrence aircraft was not originally equipped with a stall warning system, such a system is available for the DHC-2, in the form of an approved modification (MOD 2/973) from Viking Air Limited, which is the current holder of the DHC-2 type certificate. Viking Air Limited has also designed an improved modification (MOD 2/1605) to the previously offered stall warning system that provides a visual and aural warning of an impending stall.

Normal takeoff

The DHC-2 flight manual indicates that a normal takeoff is made with the fuel selector at the desired position, flaps in the TAKE-OFF position, and at maximum permissible take-off power. At a safe height, a power reduction is required, and a climb speed of 80 mph should be established, which is the speed for the best angle of climb. According to the flight manual, the flaps should be retracted to the CLIMB setting at an altitude of 500 ft.

Many DHC-2 operators, choose to retract flaps to the CLIMB setting following the initial power reduction when obstacle clearance is assured, which would result in the flaps being set to CLIMB at an altitude lower than 500 ft.

Emergency procedures

Engine failure after takeoff

The DHC-2 flight manual contains a section on engine failures after takeoff: the first item calls for the pilot to “lower the nose immediately, to maintain airspeed at 65 mph.” The final item of the procedure is capitalized and is followed by two caution messages:

> (j) KEEP STRAIGHT AHEAD AND CHANGE DIRECTION ONLY ENOUGH TO MISS OBSTACLES.
> USE RUDDER ONLY.
>
> CAUTION
>
> Always maintain enough airspeed to assure full control of aircraft to point of touchdown.
> Coarse use of ailerons near the stall airspeed precipitates wing dropping.
>
> CAUTION
>
> It is better to ride an aircraft with a dead engine safely to a crash landing straight ahead, than to turn back to the field.
> Attempts to turn back have, in many instances, ended with an uncontrolled roll or spin into the ground.

The DHC-2 flight manual also contains guidance for an engine failure above 800 ft after takeoff, requiring a glide speed of 92 mph, and allowing for a decision to turn back to the departure point if altitude allows.

A gliding distance chart is included in the flight manual. A note below the chart indicates that a float-equipped DHC-2 with flaps up, gliding at 92 mph in still air, will cover a straight-line distance of 3¼ statute miles (SM) for every 2 000 ft of altitude above ground. The gliding distance chart does not include data for DHC-2 gliding distances at 65 mph.

Meteorological information

The nearest reporting station to the occurrence site was at Wawa Airport (CYXZ), Ontario, approximately 11 NM southwest of CNH6. At the time of the occurrence:

- the wind was variable between 310° true (T) and 010°T at 12 knots (kt) and gusting to 18 kt,
- visibility was 15 SM,
- the temperature was 14°C and dew point was 13°C,
- the ceiling was broken at 1 200 ft AGL, and there were additional broken layers of cloud at 2 400 ft AGL and 4 200 ft AGL.

Aerodrome information

CNH6 is a registered private water aerodrome located on Hawk Lake, approximately 1 NM south of the town of Hawk Junction, at an elevation of 1 030 ft mean sea level.

Hawk Lake is oriented on a southwest to northeast axis and is over 10 000 ft long. The lake is over 2 000 ft wide at its midpoint, narrowing to approximately 900 ft at the northeast end.

Prevailing winds are from the west or southwest in the summer, resulting in most of the takeoffs being conducted toward the southwest, originating near the Hawk Air dock.

The geography surrounding CNH6 includes heavily forested areas, areas of rising terrain, small streams, marshlands, and lakes. Aside from a water landing, there are very few places on land where a forced landing could be conducted without the likelihood of significant damage to the aircraft and potential injury to the occupants.

Wreckage and impact information

At the site of the accident, a hydro pole located near the trailing edge of the left wing and a fence located near the trailing edge of the right wing were undamaged. This is consistent with the aircraft impacting the gravel-covered terrain in a very steep nose-down attitude; the left wing was slightly lower than the right. The damage to the aircraft was consistent with the early stages of an incipient spin. A single electrical transmission line (of a set of three transmission lines) was severed by the left elevator, which became separated from the aircraft as a result.

The propeller blades showed chordwise scratching, and one blade had dug into the gravel surface. However, damage to the propeller hub suggests very little rotation at the time of impact. There was significant impact damage to the engine case and cylinders, and to the accessory parts on the rear of the engine.

The front and centre fuel tanks were ruptured, and fuel leaked from the aircraft soon after the impact. The rear fuel tank was undamaged and did not contain any traces of fuel. Examination of the fuel system at the site did not reveal the presence of fuel in the selector valve itself, the fuel lines leading to the engine, or the carburetor float bowl. The fuel system downstream of the selector valve, up to and including the carburetor, was damaged by the impact, which allowed fuel to drain from the wreckage.

A detailed examination of the engine and its accessory parts did not reveal any mechanical anomalies that may have existed before the impact.

The flap actuator was recovered at the site, and measurement of the actuator position indicated that the flaps were set to CLIMB at the time of the occurrence.

Organizational and management information

The operator

The primary business of the operator is fly-in vacations, mostly for the purpose of fishing. The company operates a network of remote camps, and its aircraft are used to transport passengers and camp maintenance personnel, as well as cargo, to these camps. Hawk Air also conducts charter flights carrying passengers and/or cargo to camps owned privately or by other companies. At the time of the occurrence, it employed three full-time pilots, two of whom also occupied management positions.

Air-taxi training

The CARs require air-taxi operators to “establish and maintain a ground and flight training program.” Section 723.98 of the *Commercial Air Service Standards* (CASS) specifies that “[t]he syllabus of each training program shall include the programmed time allotted and subject matter to be covered.” Initial training for the DHC-2 requires 5.5 hours of ground training and 3 hours of in-flight training, while annual recurrent training requires 2.5 hours of ground training and 1 hour of in-flight training.

Subsection 723.88(2) of the CASS states that for pilots flying day VFR only, “the chief pilot, or a pilot delegated by the Chief Pilot, shall be responsible for the training and shall certify the competency of each pilot on the most complex single-engine aeroplane to be flown.” This certification is known as a pilot competency check and is completed on an annual basis in conjunction with recurrent training.

The air-taxi sector includes a wide variety of operators, operating environments, and aircraft types, configurations, and classes. The training requirements for airborne training required by Transport Canada (TC) for this diverse sector do not include many items that are specific to a particular type or class of aircraft. Individual operators are left to determine how to address the training that may be required for their specific aircraft types and classes, and for their type of operation. An operator’s training program is outlined in its operations manual, which is approved by TC. The approved training program is considered to be adequate as long as the training is provided to the pilots as set out in the manual. To assess compliance and ensure that all applicable training has been completed, TC can verify the completed training forms.

Airborne training

Many air-taxi operators in Canada use aircraft for which there is no flight simulator that can replicate aircraft performance in realistic conditions, especially in a floatplane configuration. As a result, the training must take place while in flight.

Subsection 723.98(10) of the CASS, which sets out the requirements for airborne training programs, begins with the following statement: “Any simulated failures of aeroplane systems shall only take place under operating conditions which do not jeopardize safety of flight.”

Three of the exercises required by the CASS pertain to this occurrence:

> (a) Standard Operating Procedures for normal, abnormal and emergency operation of the aeroplane systems and components including: [...]
>
> (vi) simulated engine fire and failure;
>
> [...]
>
> (xvii) approach to the stall and recovery procedure simulating ground contact imminent and ground contact not a factor (clean, take-off and landing configuration);
>
> (xviii) buffet onset boundary, steep turns (45° of bank) and other flight characteristics (as applicable for initial and upgrade only)[…]

The airborne training requirements for air-taxi operators stipulate that an approach to stall must be made, with clean, take-off, and landing flap configurations. It is also required to simulate one of these stalls with what CASS terms "ground contact imminent," which is done by assigning an altitude that represents the ground level. There is no requirement for the aircraft to be fully stalled during airborne training.

TC does not provide any guidance on how these manoeuvres are to be demonstrated by a training pilot or performed by the pilot being trained, either during initial training or recurrent training. Operators can find specific guidance for many of the training manoeuvres in the applicable aircraft flight manual. Generic guidance can be found in TC's Flight Instructor Guide (TP 975).

TSB air transportation safety issue investigation report on air-taxi operations in Canada

On 07 November 2019, the TSB published its air transportation safety issue investigation report on air-taxi safety in Canada. One of the safety themes examined in this report is the training of pilots and other flight operations personnel.

Because of the nature and diversity of air-taxi operations, operators are exposed to risks that would not typically be seen in other types of operations (such as airline operations): unprepared landing sites, float-equipped aircraft, helicopter operations, locations with poor or no weather reporting, pilot self-dispatch, etc.

Many pilots entering the air-taxi sector have little experience outside of a training environment, and often a job with an air-taxi operator is their first job as a pilot. In many cases, they may also have been taught to fly by flight instructors who themselves have little or no experience in the air-taxi sector.

The industry consultations that were carried out in 2016 as part of this safety issue investigation provided information about what operators perceived to be their most significant risks, what they were doing to lessen those risks, and what more they believed needs to be done. It should be noted that this information represents the views of those who participated in the safety issue investigation, and these views have not been independently validated by the TSB. These observations also do not reflect ongoing initiatives by service providers or the regulator.

When asked which issues led to the highest risk to safety, among other topics, operators described a number of issues related to training for pilots and other flight operations personnel (e.g., flight followers or other required company positions).

Specifically, the operators perceived that:

> [t]raining requirements in air-taxi operations are less stringent or have deficiencies. Training time allotted for mandatory training is too short to provide adequate training on the content, and mandatory content is being added without additional time allotted. Furthermore, training materials are unavailable or have not been modernized by TC.

The operator training

The operator's initial pilot training on the DHC-2 includes a minimum of 3 hours of flight time on type; the annual recurrent training includes a minimum of 1 hour of flight time on type.

Completed training is documented on company forms, which are used to track progress and verify that training has been completed.

Traditionally, the recurrent training would occur at the beginning of the season, usually in early May. However, in 2018, the operator conducted the recurrent training for all three company pilots in October, with the rationale that the pilots would be ready to fly in May 2019 when the flying season began. However, skills can deteriorate over time, and there were several months where pilots were not flying after the recurrent training. As a result, they may not have been as skilled in emergency procedures when compared with training at the start of the season.

Training was conducted by the chief pilot or the operations manager. According to the training records, the occurrence pilot had completed all required exercises satisfactorily during his recurrent annual training in October 2018.

It was common practice to conduct some additional in-flight training at the start of the float flying season. This training would be conducted during positioning flights with no passengers or cargo on board, when the opportunity presented itself. During these flights, the aircraft would be at a relatively light weight with a centre of gravity closer to the forward limit than it would normally be while carrying passengers and/or cargo.

Flight training syllabus

According to the company flight training records, the pilot had received engine failure training as part of the recurrent annual training that occurred in October 2018. In addition, it was reported that informal engine failure training was conducted during the 2019 float flying season.

The pilot's training documents indicate that training for approach to the stall had also been completed in October 2018. However, the documents are not specific as to what configuration (clean, landing, or take-off) the aircraft was in during the training.

It was reported that, although not required by existing regulations, the occurrence pilot did conduct full stalls in the aircraft while in clean configuration (flaps-up) during the course of his training.

DHC-2 fuel management

The DHC-2 flight manual contains a section on fuel management, which states: "For favourable CG [centre of gravity] travel […], [e]mpty rear tank first, if aircraft is fully loaded, in order to move the CG progressively forward."

Pilots were trained to fuel the front tank first, the centre tank second, and the rear tank last, taking only enough fuel for the planned flight plus VFR reserves. Pilots were also trained to empty the tanks in the reverse order: the rear tank first, the centre tank second, and the front tank last, with the fullest tank being used for takeoff and landing. Pilots normally fuel their own aircraft before departure, based on their pre-flight calculations, which they enter on the load record.

For most itineraries, including that on the day of the occurrence, there would be no fuel carried in the rear tank, as the fuel required could be contained in the front and centre tanks. As the front tank was normally the fullest tank, it would normally be the one selected for takeoff and landing. The DHC-2 flight manual includes an item in the take-off checks that requires the pilot to verify or move the fuel selector position to the desired tank before commencing takeoff.

There is no indication that any fuel had been added to the rear tank before the departure of the occurrence flight. The aircraft had been flown the previous day by a different pilot, who had not added fuel to the rear tank. It could not be determined how much fuel was in the rear tank at the time of departure on the occurrence flight.

Turning back following engine failure

If a mechanical problem occurs during takeoff that necessitates an immediate landing, pilots are faced with either attempting to carry out a forced landing in an unsuitable location—risking damage to the aircraft and injury to themselves—or attempting a 180° turn back toward the departure point.

TC's *Flight Training Manual* states the following:

> Numerous fatal accidents have resulted from attempting to turn back and land on the runway or aerodrome following an engine failure after take-off. As altitude is at a premium, the tendency is to try to hold the nose of the aircraft up during the turn without consideration for the airspeed and load factor. These actions may induce an abrupt spin entry. Experience and careful consideration of the following factors are essential to making a safe decision to execute a return to the aerodrome:
>
> 1. Altitude
> 2. The glide ratio of the aircraft
> 3. The length of the runway
> 4. Wind strength/ground speed
> 5. Experience of the pilot
> 6. Pilot currency on type

When taking off over an area that is not suitable for a forced landing, pilots benefit from having a plan for dealing with an emergency. The plan should take into account several factors, including terrain, altitude, the aircraft's glide ratio, and wind strength. It should also include the minimum altitude at which a 180° turn would be attempted in order to return to the take-off point after an engine failure.

Aerodynamic stall

An aerodynamic stall occurs when a wing's angle of attack exceeds the critical angle at which the airflow begins to separate. When a wing stalls, the airflow breaks away from the upper surface and the amount of lift will be reduced to below that needed to keep the wing flying. While stalls occur at a given angle of attack, they can happen at any speed.

The typical recovery from a stall initially involves pushing the yoke forward (elevator down) to break the stall and achieve flying speed, levelling the wings, and applying power. When the aircraft accelerates to a speed that provides a safe margin above stalling speed, the recovery to the original or required altitude and configuration can be completed.

Airspeed is often used to predict stall conditions. The faster an airplane flies, the less angle of attack it needs to produce lift equal to weight. As the airplane slows down, the angle of attack needs to be increased to create the lift equal to weight. If an aircraft were to slow further, the angle of attack will be equal to the critical (stall) angle of attack at some point. Stall speed is the speed below which the airplane cannot create enough lift to sustain its weight in flight.

The speed at which a stall occurs depends on a number of things, including the load factor, the weight of the aircraft, and the centre of gravity.

Manoeuvring load factor

The manoeuvring load factor is "the total aerodynamic lift on the aeroplane, acting perpendicularly to the flight path, divided by the weight of the aeroplane."

During straight and level flight, lift and weight are equal, and the load factor is 1. To maintain level flight when an aircraft is banked, the vertical component of lift must be increased to equal the weight of the aircraft; this is accomplished by increasing the angle of attack of the wing by pulling on the elevator control to maintain altitude (Figure 4).

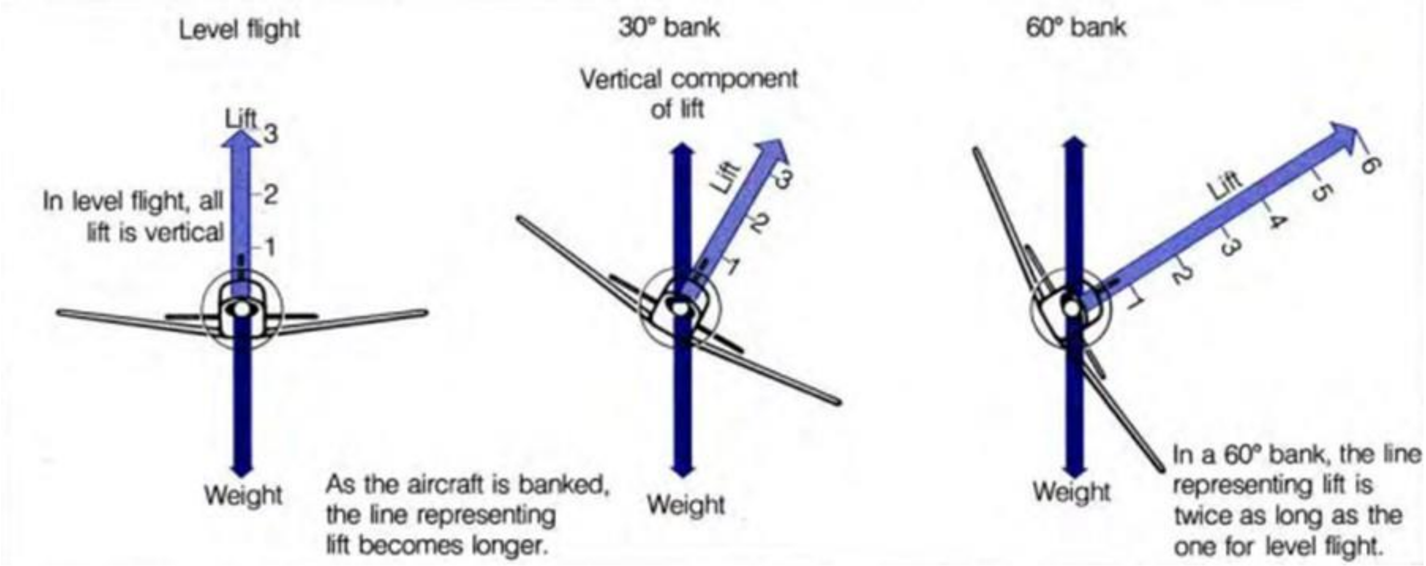


Figure 4. Relationship between lift and angle of bank (Source: Transport Canada, TP 1102E, Flight Training Manual Aeroplane, 4th edition [Revised], *p. 63)*

Increasing the angle of bank increases the load factor and the aircraft's stalling speed because it causes the aircraft to perform as if it is heavier. At a 60° angle of bank, the load factor is 2, meaning that the aircraft performs as if it is twice as heavy as it would be in level flight. The stall speed is increased by 40% at a 60° angle of bank (Figure 5).

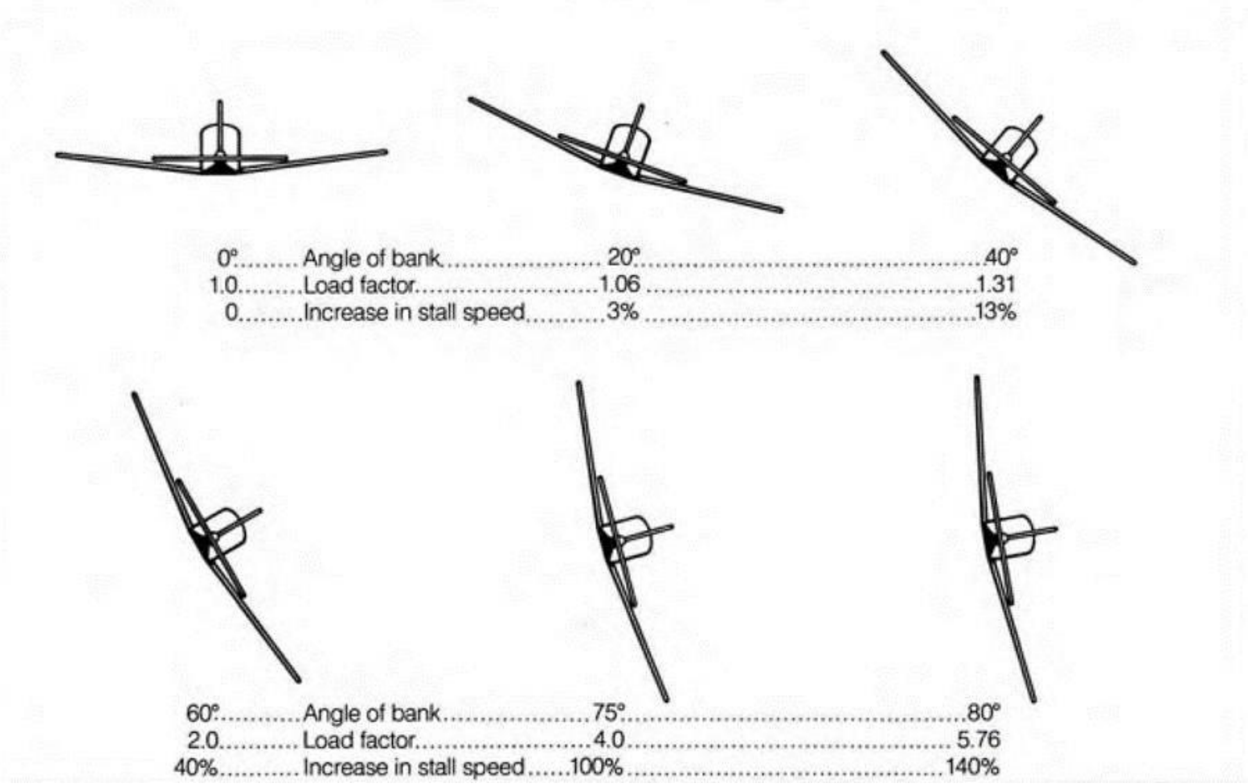


Figure 5. Relationship between angle of bank, load factor, and basic stall speed (Source: Transport Canada, TP 1102E, Flight Training Manual Aeroplane, 4th edition [Revised], *p. 63)*

Weight

An increase in aircraft weight results in an increase in stalling speed, as the wing is required to produce more lift to maintain level flight, bringing its angle of attack closer to the critical angle.

Centre of gravity

The location of the centre of gravity, even while remaining within aircraft limitations noted in the flight manual, will have an effect on the stalling speed and manoeuvrability of an aircraft.

A more forward centre of gravity requires more tail-down force to be applied to maintain the desired attitude; it will result in a higher angle of attack to maintain the same flight path, bringing the wing closer to the critical angle, resulting in an increased stall speed. Recovery from a stall is easier because there is less forward control input required to break the stall.

A rear centre of gravity works in the opposite manner, as it reduces the tail-down force and requires a lower angle of attack to maintain the desired flight path. This reduces the speed at which the aircraft will stall, which seems desirable; however, it has some negative effects on the stall characteristics, including decreased longitudinal stability, violent stall characteristics, and reduced control effectiveness during stall recovery.

Analysis

The investigation determined that the aircraft was maintained in accordance with existing rules and regulations, and that the occurrence flight was operating within the rules and guidelines laid out in the *Canadian Aviation Regulations* (CARs) and the company operations manual.

Sequence of events

The investigation revealed that a low fuel-pressure indication and power loss occurred shortly after takeoff, when the aircraft was at an altitude of approximately 300 to 400 ft AGL. The aircraft subsequently stalled, entered a spin to the left, and impacted the ground.

Two scenarios were considered to explain why the aircraft stalled:

> Since the aircraft was near the maximum gross weight in a climb configuration when the power loss occurred, a brisk nose-down input and a significant nose-down attitude would have been required to maintain the airspeed at 65 mph. The pilot did not keep the aircraft above the stalling speed, which resulted in an aerodynamic stall leading to an incipient spin and loss of control.
>
> The pilot began a left turn in an effort to return to Hawk Lake, or toward a more suitable site for a forced approach. A banked attitude during a turn increases the load factor, which results in an increase in stall speed. Any tightening of the turn further increases the load factor, causing a further increase to the stall speed. Due to the aircraft's banked attitude in a descending turn, the left wing dropped abruptly, and the aircraft entered an incipient spin. This is considered the most likely scenario.

Fuel starvation

Damage to the propeller indicates that there was some rotation at the time of the impact, suggesting that the propeller was windmilling.

During examination of the wreckage at the occurrence site, the fuel selector and cable-operated selector valve were found set to draw fuel from the rear tank, which was undamaged and contained no traces of fuel. Fuel starvation appears to be the most likely cause of the power loss experienced by the occurrence aircraft.

It could not be determined why the fuel selector was set to draw fuel from the rear tank, nor when that selection was made. These are three scenarios that were considered to try to explain this rear-tank selection:

1. The pilot switched the fuel selector to the REAR TANK following the low-fuel-pressure indication or subsequent power loss, in an attempt to re-establish the flow of fuel to the engine or possibly to select the OFF position per the emergency procedure for engine failure after takeoff.
2. The fuel selector was already in the rear tank position when the pilot arrived at the aircraft on the morning of the occurrence, and he did not notice it during his pre-flight check or taxi out.
3. The pilot became aware that there was some fuel in the rear tank and decided to be proactive by using this residual fuel during the long taxi to the take-off position.

The aircraft likely departed with the fuel selector set to the rear tank position, which did not contain sufficient fuel for departure. As a result, the engine lost power due to fuel starvation shortly after takeoff during the initial climb.

Turning back

The *DHC-2 Beaver Flight Manual* and the operator *Operations Manual* both indicate that, in the event of an engine failure, the pilot should land straight ahead. In this occurrence, landing straight ahead would likely have resulted in a crash landing into a tree-covered hillside. Pilots will instinctively avoid this type of situation; however, a straight-ahead landing, even if into trees, allows the pilot to maintain control of the aircraft further into the crash sequence and improve the occupants' chances of survival. Due to the aircraft's low altitude at the time of the power loss, the pilot would likely not have been able to glide far enough to reach a landing spot in his forward view that could reduce or eliminate the possibility of injury to himself or damage to the aircraft.

The *DHC-2 Beaver Flight Manual* and the operator *Operations Manual* both require landing straight ahead following an engine failure after takeoff. However, after a loss of engine power at low altitude, a left turn was likely attempted in an effort to either return to the departure lake or head toward more desirable terrain for a forced landing. The aircraft stalled aerodynamically, entered an incipient spin, and subsequently crashed.

Stall warning system

The occurrence aircraft was not equipped with a stall warning system. While it may not have changed the outcome had such a system been installed, it may have given the occurrence pilot a clearer indication that a stall was imminent. Without a clear indication of imminent stall, the pilot would have had to rely on airframe buffeting during an already unfamiliar situation following a power loss.

Training

Air-taxi training requirements

The required airborne training exercises for air-taxi operators set out in Subpart 723 of the CASS include an approach to stall, made with clean, take-off, and landing flap configurations. There is no requirement, however, to actually stall the aircraft. This prevents pilots from becoming familiar with the aircraft's stall characteristics, and the aerodynamic cues that may occur during a developing stall.

The operator training

The investigation found that the training received by the pilot met the requirements set out in the CASS.

However, some of the operator training methods, including training during regular operations (empty or positioning flights) and briefing emergency procedures (either on the ground or while airborne) rather than demonstrating or practising them, are likely not as effective as more structured training events.

In addition, annual recurrent training was completed at the end of the 2018 operating season so that pilots would be ready for the 2019 season. Although it was not documented, it was reported that training and/or supervision did occur during the initial weeks of the 2019 float flying season. However, skills can deteriorate over time, and there were several months where pilots were not flying after the recurrent training. As a result, they may not have been as skilled in emergency procedures when compared with training at the start of the season.

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.

- The aircraft likely departed with the fuel selector set to the rear tank position, which did not contain sufficient fuel for departure. As a result, the engine lost power due to fuel starvation shortly after takeoff during the initial climb.
- After a loss of engine power at low altitude, a left turn was likely attempted in an effort to either return to the departure lake or head toward more desirable terrain for a forced landing. The aircraft stalled aerodynamically, entered an incipient spin, and subsequently crashed.

Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences.

- If aircraft are not equipped with a stall warning system, pilots and passengers who travel on these aircraft will remain exposed to an elevated risk of injury or death as a result of a stall at low altitude.
- If air-taxi training requirements do not address the various classes of aircraft and operations included in the sector, there is a risk that significant type-, class-, or operation-specific emergency procedures will not be required to be included in training programs.
- If seasonal air operators conduct recurrent training at the end of the season rather than at the beginning, there is a risk that pilots will be less familiar with required emergency procedures.
- If air operators do not tailor their airborne training programs to address emergency procedures that are relevant to their operation, there is a risk that pilots will be unprepared in a real emergency.
- If pilots and passengers do not use available shoulder harnesses, there is an increased risk of injury in the event of an accident.

TSB Final Report A20O0053—Mid-air Collision

History of the flights

At approximately 1405 on 14 June 2020, a privately registered Champion 7GCB aircraft equipped with floats departed Golden Lake, Ontario, for a daytime visual flight rules (VFR) flight to Constance Lake Water Aerodrome (CNQ5), Ontario. Only the pilot was on board.

After departure, the aircraft climbed to 2 600 ft above sea level (ASL) and followed a direct track to the area of Braeside, Ontario, along the Ottawa River, approximately 3.5 nautical miles (NM) northwest of Arnprior/South Renfrew Municipal Aerodrome (CNP3), Ontario. The pilot was monitoring the en-route frequency (126.7 MHz) and made a position report as he passed the town of Renfrew, Ontario. As the Champion approached Braeside, the pilot switched over to the aerodrome traffic frequency for CNP3 (122.7 MHz) and broadcast his intentions to remain along the Ontario side of the Ottawa River en route to CNQ5.

As the Champion approached Chat Falls on the Ottawa River, the pilot started a descent to 1 500 ft ASL. He broadcast on frequency 122.7 MHz that he was clearing the area of CNP3 and subsequently switched over to a training area frequency (123.35 MHz). The pilot made a position report when he was passing Mohr Island on the Ontario side of the Ottawa River.

The Champion was on a track of approximately 085° true at 1 500 ft ASL.

At approximately 1435, a privately registered Cessna 172M aircraft departed CNP3 with the pilot and three passengers on board, for a daytime VFR flight east to the area of Constance Bay.

After departure from CNP3, the Cessna climbed to 1 500 ft ASL. The pilot was monitoring the aerodrome traffic frequency for CNP3 (122.7 MHz) and remained on that frequency for approximately 5 NM before switching over to the training area frequency (123.35 MHz) and broadcasting the aircraft's position and his intentions for the flight. The Cessna maintained an altitude of 1 500 ft ASL, which in that area is approximately 1 000 ft above ground level (AGL).

After making a few sightseeing orbits over an area just east of Fitzroy Harbour, the Cessna flew a track of approximately 050° true, parallel to Galetta Side Road, towards Buckham's Bay, Ontario, on the Ottawa River. It maintained an altitude of 1 500 ft ASL.

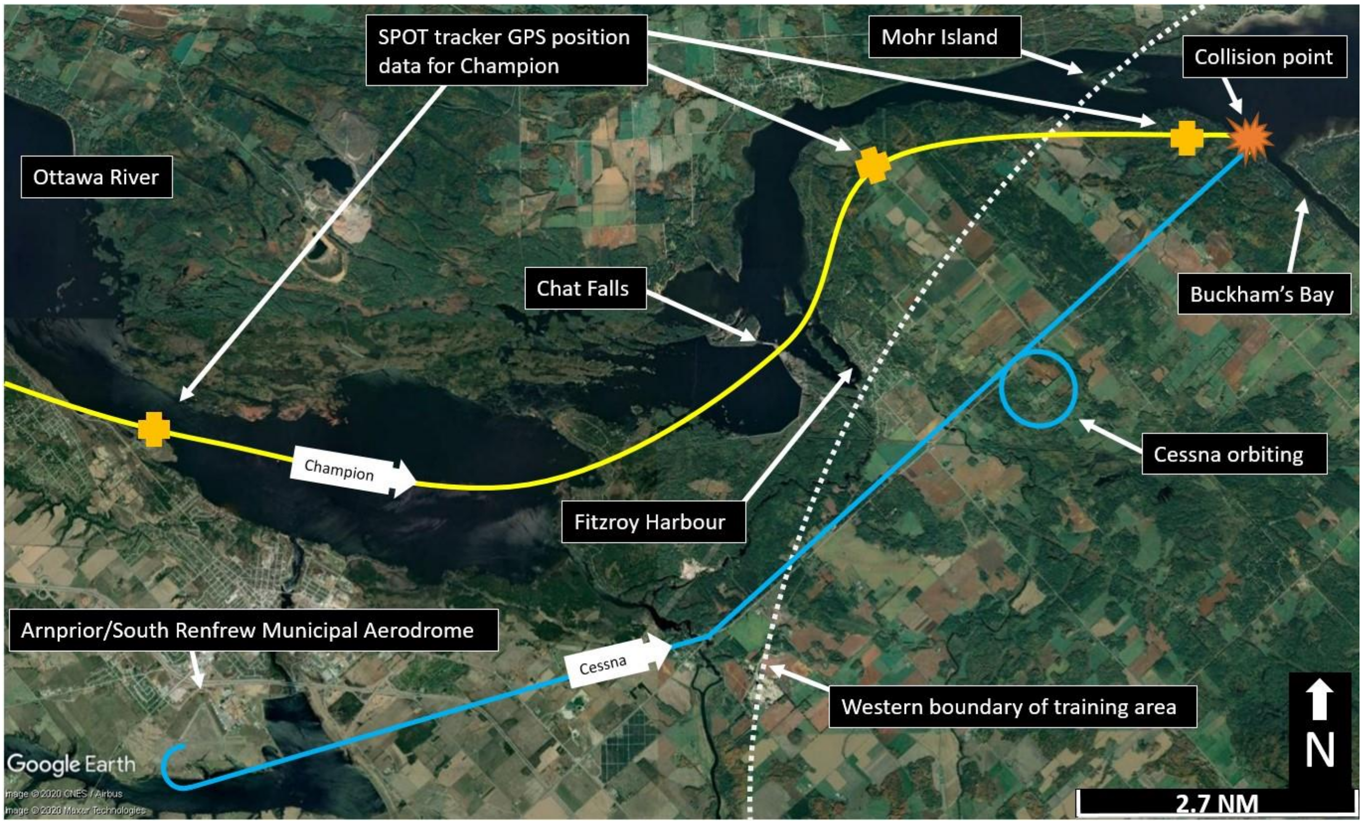


Figure 1. Estimated flight paths of the Champion and the Cessna (Source: Google Earth, with TSB annotations)

At approximately 1446, the two aircraft collided while flying over the Ottawa River near Buckham's Bay, approximately 12 NM east-northeast of CNP3 (Figure 1).

The Champion sustained damage to the tail, entered a descending left-hand turn, struck the water, and overturned. The pilot egressed from the aircraft and was rescued by nearby boaters. The pilot received minor injuries.

The Cessna sustained damage to the propeller, nose wheel fairing and engine cowl. The pilot of the Cessna saw the Champion aircraft strike the water. He flew a few orbits to confirm that the pilot of the Champion had been rescued and transmitted a Mayday call. He then flew back to CNP3 and landed without further incident.

Pilot information

Records indicate that both pilots were certified and qualified for the flight in accordance with existing regulations.

The pilot of the Champion held a private pilot licence and had a valid Category 3 medical certificate.

The pilot of the Cessna held a private pilot licence and a valid Category 3 medical certificate.

Aircraft information

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

Collision and wreckage information

The damage sustained by both aircraft is consistent with the angle of the collision and correlates well with the direction of flight and converging tracks.

Damage to the Champion

During the collision sequence, the Champion sustained two propeller strikes on the top of the right wing: one close to the wing tip, along the trailing edge of the wing, and the other on the right aileron. The tail was extensively damaged in the collision (Figure 2). The damage caused the pilot to lose the ability to control the aircraft using the ailerons, horizontal stabilizer, or the rudder. He was, however, able to control the pitch of the aircraft using engine power. Increasing the engine power would pitch the nose of the aircraft up, while decreasing it would pitch the nose down.

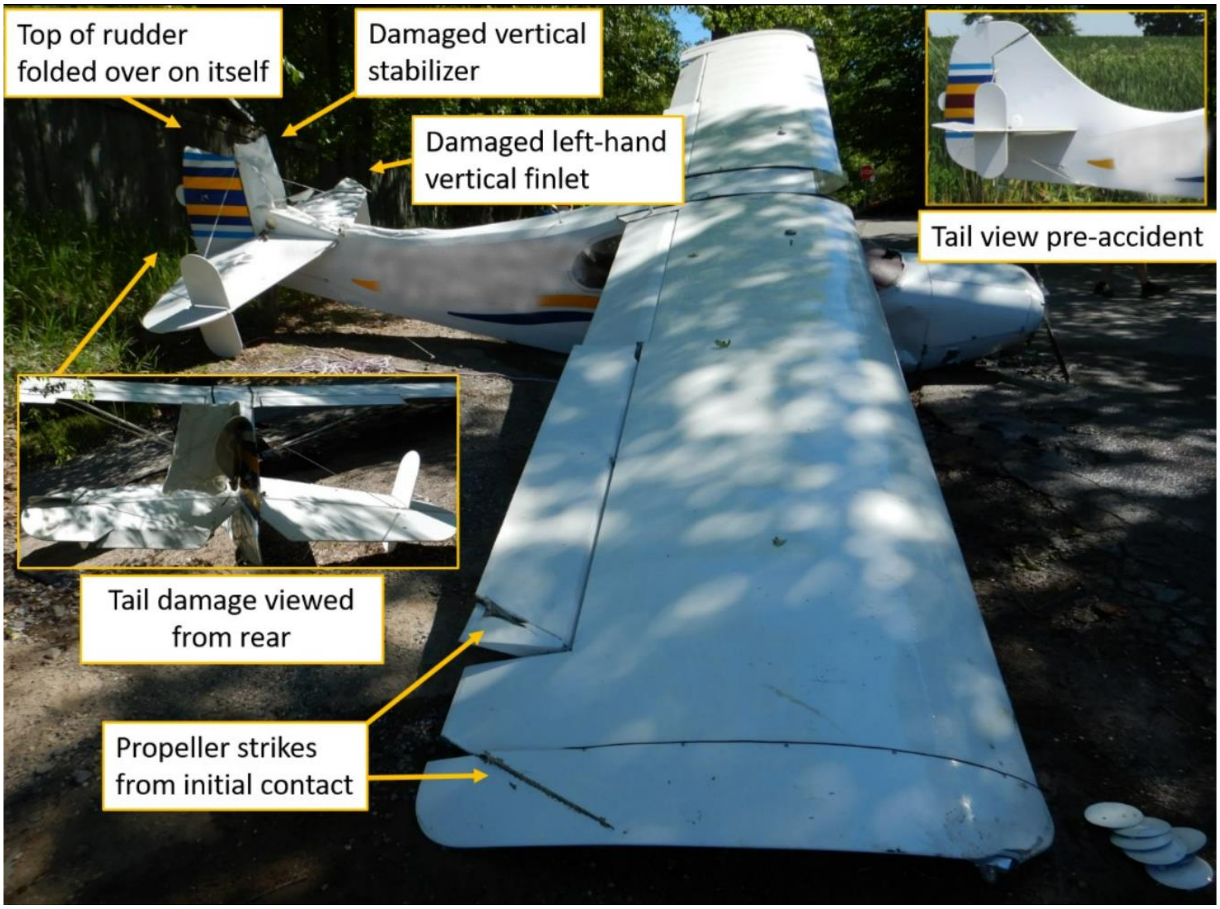


Figure 2. Damage to the Champion (Source of main image and tail damage inset image: TSB. Source of tail view pre-accident inset image: third party, with permission)

Damage to the Cessna

The damage to the Cessna consisted of some scraping and paint marks on both propeller blades, a damaged front wheel fairing, and some damage to the left-hand engine cowl and lower left-hand portion of the fuselage immediately aft of the firewall (Figure 3). The damage did not lead to any control issues for the pilot.

Figure 3. Damage to the Cessna (Source: Ottawa Police Service, with TSB annotations)

Airspace and radio procedures en route

The collision occurred in Class G uncontrolled airspace, "…within which ATC [air traffic control] has neither the authority nor the responsibility to exercise control over air traffic."

The *Transport Canada Aeronautical Information Manual* states:

> Pilots operating VFR en route in uncontrolled airspace when not communicating on an MF [mandatory frequency], or an ATF [aerodrome traffic frequency], or VFR on an airway should continuously monitor 126.7 MHz and whenever practicable, broadcast their identification, position, altitude and intentions on this frequency to alert other VFR or IFR [instrument flight rules] aircraft that may be in the vicinity. Although it is not mandatory to monitor 126.7 MHz and broadcast reports during VFR or VFR-OTT [over-the-top] flights, pilots are encouraged to do so for their own protection.

The area where the collision occurred is designated as a training area below 4 000 ft within the Ottawa terminal control area. The Ottawa terminal control area VFR Terminal Procedures Chart indicates that training aircraft should monitor 123.35 MHz below 4 000 ft ASL when operating in that area.

Both pilots were familiar with the local area and indicated that they had made a position report on 123.35 MHz as they entered the designated training area. However, neither pilot recalled hearing any radio transmissions concerning other aircraft in their immediate vicinity.

Visual lookout

As stated in the *Transport Canada Aeronautical Information Manual*:

> When operating in accordance with VFR, or in accordance with IFR but in VMC [visual meteorological conditions], pilots have sole responsibility for seeing and avoiding other aircraft. Aural and visual alertness are required to enhance safety of flight in the vicinity of uncontrolled aerodromes.

The see-and-avoid principle is the basic method of collision avoidance for VFR flights that is based on active scanning, and the ability to detect conflicting aircraft and take appropriate measures to avoid them. It has been examined in a number of other TSB investigations, and the TSB has found that, "[b]ecause of its limitations, the see-and-avoid principle cannot be used as the sole means of preventing aircraft collisions when operating under visual flight rules."

Advisory circular AC 90-48D published by the U.S. Federal Aviation Administration states that "[p]ilots should remain constantly alert to all traffic movement within their field of vision, as well as periodically scanning the entire visual field outside of their aircraft to ensure detection of conflicting traffic." The most effective method of identifying potential conflicting traffic is to quickly scan small segments of the visual field (approximately 10° to 15° wide) to detect movement.

Both aircraft are of a high-wing design and the visibility would have been similar, with no obvious obstructions.

Lack of relative motion on collision course

In its report on the limitations of the see-and-avoid principle, the Australian Transport Safety Bureau explained the following:

> The human visual system is particularly attuned to detecting movement but is less effective at detecting stationary objects. Unfortunately, because of the geometry of collision flightpaths, an aircraft on a collision course will usually appear to be a stationary object in the pilot's visual field.
>
> If two aircraft are converging on a point of impact on straight flightpaths at constant speeds, then the bearings of each aircraft from the other will remain constant up to the point of collision […].
>
> From each pilot's point of view, the converging aircraft will grow in size while remaining fixed at a particular point in his or her windscreen.

Time required to recognize threat and take evasive action

Table 1. Aircraft identification and reaction time chart (Source: U.S. Federal Aviation Administration, Advisory Circular [AC] 90-48D: *Pilots' Role in Collision Avoidance*, Change 1 [28 June 2016], paragraph 4.2.1.)

Event	Seconds
See Object	0.1
Recognize Aircraft	1.0
Become Aware of Collision Course	5.0
Decision to Turn Left or Right	4.0
Muscular Reaction	0.4
Aircraft Lag Time	2.0
TOTAL	12.5

U.S. Federal Aviation Administration AC 90-48D[1] provides data (Table 1) regarding the attention and response time to traffic movement. The AC states in part:

> Research has shown that the average person has a reaction time of 12.5 seconds. This means that a small or high-speed object could pose a serious threat if some other means of detection other than see-and-avoid were not utilized, as it would take too long to react to avoid a collision.

However, in its report on the limitations of the see-and-avoid principle, the Australian Transport Safety Bureau provided the following caveat:

> Therefore, to have a good chance of avoiding a collision, a conflicting aircraft must be detected at least 12.5 seconds prior to the time of impact. However, as individuals differ in their response time, the reaction time for older or less experienced pilots is likely to be greater than 12.5 seconds.[2]

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[1] U.S. Federal Aviation Administration, Advisory Circular (AC) 90-48D, Pilots' Role in Collision Avoidance, Change 1 (28 June 2016), paragraph 4.2.1.

[2] Australian Transport Safety Bureau, ATSB Transport Safety Report, Research Report, Limitations of the See-and-Avoid Principle, Reprinted (November 2004), paragraph 3.1.

Collision avoidance systems

Both the Champion and the Cessna were equipped with Mode C transponders. Neither aircraft was equipped with any type of aircraft collision avoidance system technology, nor was it required by regulation.

There continue to be advancements in collision avoidance technology, and a number of systems are available for general aviation aircraft to enhance the defences against mid-air collisions. These systems include:

- flight alarms branded as FLARM and/or PowerFLARM[3]
- automatic dependent surveillance—broadcast transceivers
- traffic advisory systems
- portable collision avoidance systems

Safety messages

The two aircraft in this occurrence were operating under VFR in uncontrolled airspace. Neither pilot saw the other aircraft prior to the mid-air collision, partly owing to the inherent limitations of the see-and-avoid principle. Relying solely on visual detection increases the risk of collision while in uncontrolled airspace. Pilots are strongly encouraged to broadcast their intentions and maintain a listening watch while operating in uncontrolled airspace in accordance with Transport Canada's VFR communications procedures, even though it is not mandatory for them to do so.

There are a number of airborne collision avoidance systems currently available, some of which are specifically designed for the general aviation market. These technologies offer the potential to significantly reduce the risk of mid-air collisions.

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[3] FLARM works by calculating and broadcasting its own future flight path to nearby aircraft. At the same time, it receives the future flight path from surrounding aircraft. An intelligent motion prediction algorithm calculates a collision risk for each aircraft based on an integrated risk model. When a collision is imminent, the pilots are alerted with the relative position of the intruder, enabling them to avoid a collision.