Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A13P0278

AERODYNAMIC STALL – COLLISION WITH TERRAIN

CBE CONSTRUCTION LTD.
CESSNA C-185E, C-FQGZ
WEST CRACROFT ISLAND, BRITISH COLUMBIA
24 OCTOBER 2013

Canada

Aviation Investigation Report A13P0278

Aerodynamic stall – Collision with terrain
CBE Construction Ltd.
Cessna C-185E, C-FQGZ
West Cracroft Island, British Columbia
24 October 2013

Summary

On 24 October 2013, at 1121 Pacific Daylight Time, a CBE Construction Ltd. Cessna C-185E seaplane (registration C-FQGZ, serial number 18501691) departed Port McNeill, British Columbia, water aerodrome with a pilot and 2 passengers on board for a charter flight to West Cracroft Island, British Columbia. At 1140, while manœuvring for landing on water, the aircraft departed from controlled flight and collided with terrain at an elevation of 27 feet above sea level on a small island in Potts Lagoon, West Cracroft Island. There was no fire. The aircraft was destroyed and the 3 occupants were fatally injured. No transmission was heard from the emergency locator transmitter.

Le présent rapport est également disponible en français.

Factual information

History of the flight

CBE Construction Ltd., doing business as Air Cab, is based at the water aerodrome in Coal Harbour, British Columbia, approximately 19 nautical miles (nm) west of Port McNeill, British Columbia. On the morning of 24 October 2013, C-FQGZ's (the aircraft) fuel tanks were filled to capacity with 76 U.S. gallons, or 460 pounds, of fuel, and the pilot completed the pre-flight inspection of the aircraft. At 1046,[1] after discussing the flight plan with the company owner, the pilot departed Coal Harbour on a company flight itinerary for Port McNeill water aerodrome (Appendix A). At Port McNeill, 2 passengers were briefed and provided with personal flotation devices (PFDs) prior to boarding the aircraft. All occupants wore PFDs during the flight.

At 1121, the flight departed Port McNeill for a logging operation near Potts Lagoon, West Cracroft Island, British Columbia. Shortly after takeoff, and in the vicinity of Alert Bay, British Columbia, the pilot discussed the flight conditions via radio with the pilot of another air operator also flying in the area. The accident pilot reported that he had descended to about 200 feet above sea level (asl) due to a low cloud ceiling, but had acceptable forward visibility and was continuing on to destination over the water.

Potts Lagoon is a small sheltered inlet adjacent to Clio Channel on the northwest shore of West Cracroft Island. It is not regularly used by aircraft and no aeronautical information is available to a pilot planning to land there.

The aircraft was destined to land and dock at a logging operation which was situated on a point of land near the entrance to the lagoon. The peninsula between Clio Channel and Potts Lagoon adjacent to the logging operation rises to an elevation of about 300 feet asl. Most areas of West Cracroft Island around Potts Lagoon are densely forested in hemlock and cedar trees.

At the time of the accident, the water landing area of the lagoon was observed to contain a significant amount of floating wood and naturally occurring debris.

At 1135, near the entrance of Potts Lagoon, the aircraft was observed approaching from the west. It overflew the log sorting area at an altitude of about 300 feet asl before continuing across the island and out of sight to the northeast (Figure 1). After a short period of time it returned into view. The aircraft continued to fly at low level along the shoreline and entered the lagoon.

Shortly after entering the lagoon the aircraft commenced a steep left turn back towards the intended landing area. During the turn, the aircraft rolled very steeply to the left; this was accompanied by an abrupt increase in engine sound. The aircraft crashed into tall trees on a small island in the centre of the lagoon.

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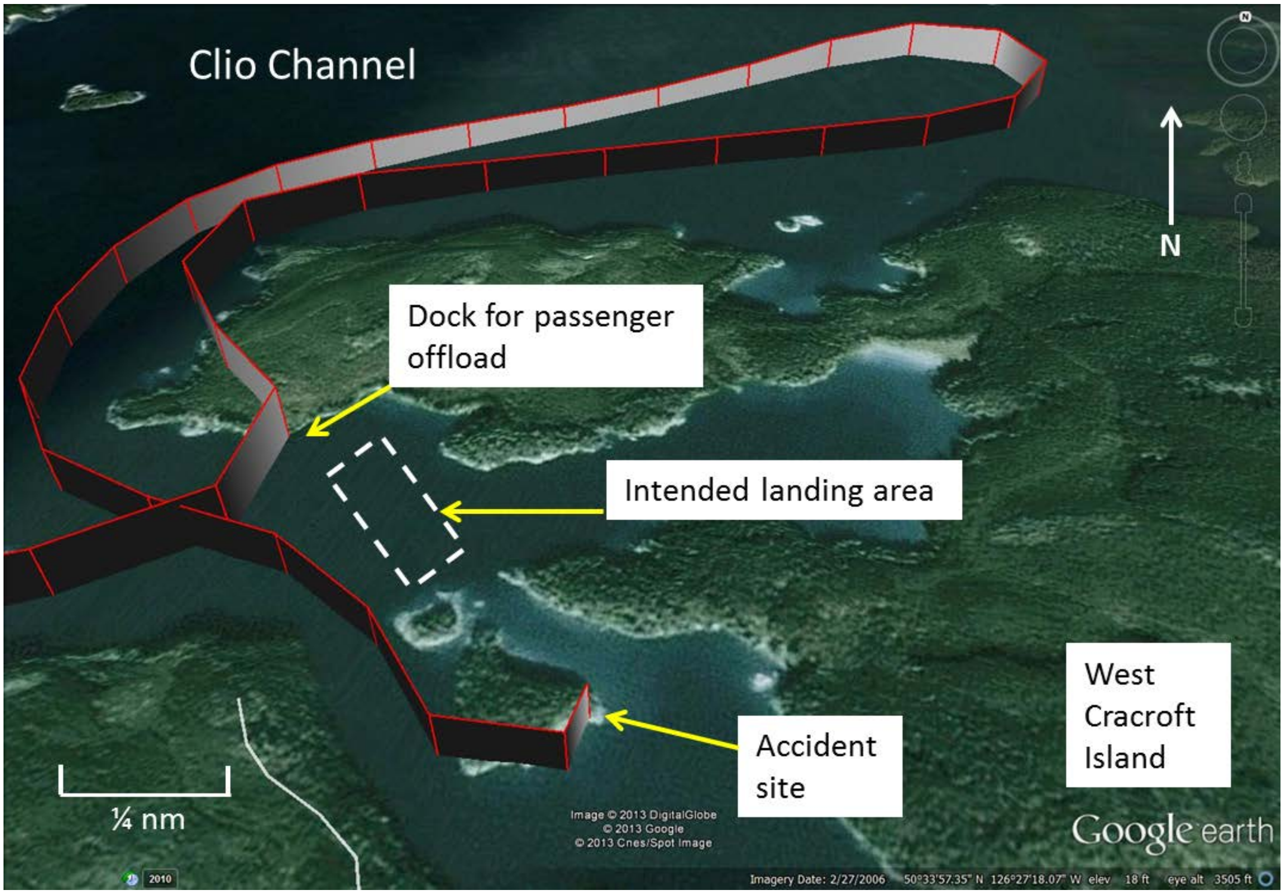
1 All times are Pacific Daylight Time (Coordinated Universal Time minus 7 hours).

Figure 1. Aircraft flight path (Source: Google Earth, with TSB annotations)



Site and wreckage information

The aircraft wreckage was examined at the accident site and at the TSB regional facility.

The aircraft came to rest, almost inverted, in heavily wooded terrain at an elevation of 27 feet asl on the larger of the 2 islands located in the entrance to Potts Lagoon (Photo 1). Tree heights in the area surrounding the accident site were approximately 75 to 80 feet above ground level (agl). Impact scarring on these trees showed the final track of the aircraft was about 350° magnetic, and that its descent angle was initially about 70° below horizontal, and steepened to vertical after it struck a stand of large trees (Photo 2).

Photo 1. Accident site looking south (Source: Sealand Aviation Ltd.)

Impact damage on the airframe indicated that the initial tree contact occurred while the aircraft was in a nose-down attitude of about 15° and left bank of about 60°. Upon impact, the left wing, left horizontal stabilizer, and vertical stabilizer separated from the airframe. Subsequent lateral impacts on the right hand side airframe and float resulted in further break-up of the aircraft. The aircraft wreckage came to rest in a localized area with most heavy components being located within 10 to 15 metres of the airframe. The left wing was found approximately 15 metres ahead of the main wreckage, in the direction of flight.

Photo 2. Wreckage and tree strike damage

The accident aircraft was equipped with 2 bladder-type fuel tanks, 1 in each of the aircraft's inboard section of the wings. The left wing fuel tank had ruptured during the initial break-up of the aircraft and separation of the left wing. As a result, most of the tank's contents were spilled away from the aircraft and from any potential ignition sources. While the right wing remained attached to the airframe, its fuel line fittings were damaged during the accident. The contents of this tank drained onto the cabin area of the airframe following the accident sequence. Samples of fuel were taken from the quantity remaining in the aircraft's tanks and fuel filter. It was of proper grade and quality, and contained no contamination.

The aircraft was equipped with 2 batteries which were located in the aircraft fuselage aft of the cabin and away from the fuel that was spilled during the accident. The high-amperage cables remained attached to both batteries. The aircraft's alternator electrical connections remained unbroken and the starter wires also remained intact, eliminating both as potential ignition sources by electrical arcing. The immediate area surrounding the wreckage was covered in low vegetation and damp soil, with little or no ignition source for the spilled fuel.

Examination of the propeller and cut marks on trees at the accident site showed damage consistent with high engine power at the time of the crash. The wing flaps and their manual selector handle were positioned at 10°, a setting appropriate for the approach phase of flight.

The aircraft was equipped with an emergency locator transmitter (ELT) designed to transmit a distress signal on 121.5 and 243 MHz in the event of a crash. The ELT was mounted in the aircraft's fuselage and was connected to an externally mounted antenna via a coaxial cable. During the accident, primary impact and deceleration loads were offset to the longitudinal axis of the aircraft and failed to activate the G switch in the unit. In addition, the ELT mounting bracket failed and the ELT antenna cable was broken.

Survivability

The pilot's and front passenger's seats were each equipped with lap and shoulder harnesses attached to the primary airframe structure at either side of the occupant seats. Both the pilot and front seat passenger used the full restraint system. During the accident sequence, both front seats separated from their floor tracks. The pilot's and front passenger's shoulder harnesses failed when the left wing and the cabin roof structure separated. Each rear passenger seat was equipped with a 2-point, lap-style safety belt. The rear seat passenger was seated in the right side seat and used the belt. The rear seat remained attached to the airframe and the belt remained fastened. All of the persons on board remained in their seats throughout the crash sequence.

The cabin area of the aircraft was heavily damaged during the accident. Numerous tree impacts shattered the windscreen, separated the cabin roof and both cabin doors. The occupiable cabin volume was compromised by trees. These conditions resulted in non-survivable injuries to all occupants.

Weather

On the day of the accident, localized areas of low ceiling and visibility were present in the vicinity of Port McNeill and West Cracroft Island.

The closest aviation weather reporting location to West Cracroft Island is Port Hardy Airport, British Columbia, 40 nm west of the accident location. The 1200 aviation routine weather report for the station stated the following: wind 060° True (T) at 4 knots, visibility 8 statute miles (sm), few clouds at 400 feet agl, broken cloud ceiling at 1600 feet agl, temperature 10°C, dew point 9°C, and altimeter 30.11 inches of mercury.

The Terminal Area Forecast issued at Port Hardy at 1138, valid from 1200, 24 October, to 0000, 25 October, within 5 nm of Port Hardy forecast: winds from 030°T at 5 knots, visibility greater than 6 sm, few clouds at 400 feet agl, with an overcast cloud ceiling at 1500 feet agl. Temporary conditions throughout the period were expected to include a visibility of 2 sm in mist and broken ceiling at 400 feet agl.

Photo 3. Image of weather in the vicinity of Port McNeill at the time of the accident (Source: Port McNeill Weather and Webcam)

Immediately following the accident, the Royal Canadian Air Force deployed a CC-115 Buffalo and CH-149 Cormorant helicopter from Canadian Forces Base Comox to the crash site. The latter arrived over the accident site roughly 50 minutes after the accident and reported a variable cloud ceiling at 400 to 500 feet agl and calm wind conditions.

Pilots in the Port McNeill area used a privately operated internet webcam for weather information. This camera was situated in Port McNeill and was oriented towards West Cracroft Island (Photo 3). It is not known if the occurrence pilot accessed this webcam prior to departure.

Company information

Air Cab operates single-engine, day visual flight rules (VFR), seaplanes under subparts 702 and 703 of the *Canadian Aviation Regulations* (CARs). Maintenance services are contracted. At the time of the accident, the company operated a fleet of 5 single-engine floatplanes on a year-round basis.

Most of the company's flights are conducted in uncontrolled Class G airspace in remote areas on the northern part of Vancouver Island, British Columbia, and north-coastal British Columbia mainland. On flights conducted at less than 1000 feet agl in uncontrolled airspace, Air Cab was approved to operate in visibility as low as 1 sm while remaining clear of cloud. The company used a Type D flight operational control system, where pilots were responsible for the creation of their own operational flight plans and dispatching their flights.

Air Cab was not required to have an approved safety management system (SMS). However, the company operations manual opens with a Safety Policy that highlights the key elements of an SMS. The company's accountable executive was well known to be directly involved with all aspects of the operation. However, company pilots were still responsible for adjusting operations at remote locations to ensure flight safety.

Pilot

The pilot held an airline transport pilot licence and was certified and qualified for the flight in accordance with existing regulations. Prior to the day of the accident, he had accumulated approximately 3137 hours total flight time, 1682 hours of which were in seaplane operations. A number of aircraft that he had flown were similar in size and performance to the accident aircraft. He had 8.5 hours of experience on the accident aircraft type.

Although he had recently returned to Port Hardy to begin work for Air Cab, the pilot had previously flown commercially in the local area for another air operator 2 years prior to the accident. During that time he had gained about 216 hours' experience in seaplanes while working during a 5 ½-month period. He also owned his own aircraft and had flown recreationally in the area. Between 14 October 2013 and 21 October 2013, the pilot completed 7 flights for a total of 5.4 hours of flying, which included his training. Prior to his flight training with Air Cab, the pilot had last flown 106 days earlier. His most recent flying had been operating seaplanes outside of Canada.

The pilot had started working for the company 10 days before the accident. During the time he had been employed by Air Cab, he had completed the company's initial flight and ground training. Company records show that he had flown a total of 3.4 hours over the course of 5 training flights. During his flight training with Air Cab, the pilot was trained in, and demonstrated proficiency in, stall recovery. As was company practice, the aircraft was flown to the first indication of the stall before recovery was initiated. Accelerated stalls[2] were not practiced nor were they required to be.

The accident occurred on the pilot's first day of unsupervised flying for Air Cab. The pilot had not flown to the Potts Lagoon area and had not flown the accident aircraft before the day of the accident; his company flight training had taken place in another of the company's C-185 floatplanes.

During the 3 days prior to the accident, the pilot worked from about 0800 to 1700 each day. On the 2 days prior to the accident, he had not flown but had been on duty at the company offices

2 See report sub-section, Stalls, for description.

in Coal Harbour. On the day of the accident, he was described as appearing in good spirits and well rested. There were no indications of any health issues that may have been factors in the accident.

Aircraft information

The float-equipped Cessna C-185E was manufactured in 1970 and imported into Canada that year. Records indicate that the aircraft was certified and maintained in accordance with existing regulations.

The accident aircraft had been modified a number of times since its date of manufacture. These modifications included installation of the following:

Robertson Short Take-off and Landing kit

The accident aircraft was modified to use a Robertson Short Take-off and Landing (STOL) kit,[3] based on a certified supplemental type certificate (STC).[4] The Robertson STOL kit was added to the aircraft by a previous owner before the aircraft was purchased by Air Cab and before it was imported into Canada. Robertson STOL kit components added to C-FQGZ included a main-wing leading edge cuff to modify the airfoil shape, wing fences, and a flap-aileron interconnect system. The interconnection of the flaps and ailerons resulted in an incremental downward deflection of the aircraft ailerons when the aircraft flaps were lowered. The increased camber from the lowered ailerons provided an increase in lift during flight. Air Cab did not possess an STC for the Robertson STOL kit on the accident aircraft and consequently had no owner-operator supplement for it.

Sportsman Short Take-off and Landing (STC SA2256WE)

The Sportsman STOL wing leading edge cuff STC was added to the aircraft in 1988. This leading edge replaced the previously installed Robertson STOL leading edge cuff. At the time of the addition of this modification, the original Robertson STOL wing fences and flap-aileron interconnect were retained. An owner–operator supplement for the Sportsman STOL was not provided by the manufacturer of the Sportsman STOL kit nor was it required by the regulator. The manufacturer of this modification kit recommended that pilots continue to adhere to Cessna performance speeds and limits.

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[3] The Robertson Short Take-off and Landing (STOL) modification increases takeoff and landing performance through a combination of improved slow-speed handling and lower aerodynamic stall speeds. The aircraft is required to be operated within the limitations of the aircraft owner–operator supplement that would provide procedures and flight performance data for the pilot of a modified aircraft.

[4] Supplemental type certification (STC) allows an aircraft owner to make approved modifications to an aircraft. These modifications are often developed, manufactured and marketed by companies other than the original aircraft manufacturer. In this report, the term "STC" also refers to a modification to an aircraft that is authorized by a supplemental type certificate for that aircraft.

Air Research Technologies wing extensions (STC SA00276NY, Canada SA 93-136)

Air Research Technologies (ART) wing extensions were added to the accident aircraft in January 2013, raising the gross takeoff weight from 3350 to 3525 pounds. An owner-operator supplement was incorporated.

EDO-Aire 3430 floats (STC SA832EA)

The aircraft was equipped with larger capacity 3430 model floats. An owner–operator supplement was not provided by EDO for 3430 use on C-185E aircraft (EDO provided this supplement beginning with the later C-185F). Accordingly, a supplement was not required with the STC.

Multiple supplemental type certificates

Each of these STC modifications was evaluated individually and approved by the regulator against an otherwise stock aircraft.

Individual STCs are approved by regulators after testing on an otherwise unmodified aircraft. Consequently, most Transport Canada-issued STCs include a compatibility statement which states, in part:

> Conditions: Prior to incorporating this modification, the installer shall establish that the interrelationship between this change and any other modification(s) incorporated will not adversely affect the airworthiness of the modified product.[5]

In addition to this statement, Transport Canada (TC) has issued Airworthiness Notices B045 - *Compatibility of Multiple Modifications*. The regulator requires the installer to ensure the modification(s) will not affect the airworthiness of the modified product and, if necessary, a new flight manual supplement may be required with the installation to prescribe the operating envelope.

The installer's evaluation of compatibility of modifications made to the aircraft had not included stall testing, and despite the aforementioned conditions, there was no requirement by the regulator for evidence that this had been accomplished.

The combined aerodynamic effects of installing multiple STCs onto a single aircraft are not typically tested by the STC holder and were not known.[6] Accordingly, there was no performance data or procedural guidance for the owner or pilots of C-FQGZ for the combination of modifications on the aircraft.

Company pilots recognized that the accident aircraft had good STOL performance, and it was generally believed that the aircraft had a stall speed of about 40 knots. In spite of this, the aircraft was typically flown during takeoff and landing at speeds similar to the company's less-

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[5] Transport Canada, Airworthiness Notices – B045, Edition 1, 15 May 1998

[6] A flight testing program was completed by the developer of the wing extension supplemental type certificate (STC) to determine aileron roll-rate effectiveness when the wing tips were to be combined with a number of other modifications; however, the program did not incorporate stall testing.

extensively modified Cessna C-185, C-FBMO, at approximately 60 knots. Company flight training, including that of the accident pilot, was conducted on C-FBMO as it was believed to be faster and more demanding of pilot technique than the accident aircraft.

The aircraft had been involved in 3 accidents prior to this occurrence. Most recently, in September 2012, it had descended onto the water with a high vertical speed after stalling in a low-level left turn.[7] The aircraft was significantly damaged. At the time of repair, the wing extension STC was added to the aircraft.

National Transportation Safety Board recommendations concerning multiple supplemental type certificates on aircraft

Following the crash of 2 light aircraft [8] in which it had determined that multiple STCs had been a factor, the National Transportation Safety Board (NTSB) issued a Safety Recommendation Letter[9] which states:

> The NTSB concludes that, without specific guidance and/or a checklist to help the installer determine the interrelationship between STCs, the installer may not be able to ensure that an appropriate evaluation is performed. As these accidents show, multiple STCs installed on an aircraft can adversely affect each other and, ultimately, the performance and structure of the aircraft if their interaction is not evaluated properly. Therefore, the NTSB recommends that the FAA develop specific guidance and/or a checklist to help installers performing STC modifications determine the compatibility and interaction between a new STC and any previously installed STCs on the aircraft to ensure that the new STC will not adversely affect the aircraft's structural strength, performance, or flight characteristics. If the guidance and/or checklist indicate any adverse effects between the STCs, additional testing and/or an engineering evaluation should be performed before installing the new STC.

In addition to this, the NTSB recommendation A-12-022 states in part that :

> The FAA instruct installers to document […] how the installer determined the compatibility and interaction between the new supplemental type certificate (STC) and previously installed STCs on the aircraft to show that the new STC will not adversely affect the aircraft's structural strength, performance, or flight characteristics.

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7 TSB occurrence No. A12P0165 (Ocean Falls, British Columbia, Air Cab, C185 C-FQGZ, Collision with water)

8 National Transportation Safety Board accident report ERA10FA140 and ERA10FA404

9 Letter from National Transportation Safety Board (NTSB) Chairman Deborah A.P. Hersman to Acting Administrator Michael P. Huerta, U.S. Federal Aviation Administration (FAA), dated May 24, 2012; re. NTSB Safety Recommendations A-12-021, A-12-022 and A-12-023

In turn, the Federal Aviation Administration (FAA) responded that it was "developing policy and guidance to address STC compatibility concerns that include proposed actions for the installer, the STC applicant, the STC approval holder and the FAA (both engineering and airworthiness inspectors)."[10]

Furthermore, the FAA stated that its Aviation Rule Making Committee was "considering recommendations for possible regulatory changes to implement more effective STC compatibility assessment procedures."[11]

Global positioning system flight tracking

Air Cab utilized a global positioning system (GPS) flight tracking system that broadcasts the position of the company's aircraft every 5 minutes. This system met the company's dispatch and flight-following requirements. The occurrence aircraft was equipped with a Skytrac ISAT-100 Airborne Data/Position Communicator, which used GPS signals to derive, among other data, the aircraft's groundspeed, altitude, and track. This information was recorded and stored in the unit's internal memory at 5-second intervals, and provided this investigation with data to reconstruct a number of the aircraft's final flights, including the accident flight path. Skytrac systems do not provide a pilot with any navigation information.

Weight and balance

A circular slide rule and papers showing the pilot's weight calculations were recovered from the aircraft. For the accident flight, the pilot had calculated the takeoff weight as 3037 pounds. A record for the pilot's centre of gravity (C.G.) calculation was not found, nor was it possible to determine if the pilot had used the slide rule in determining the aircraft's C.G. for the accident flight.

At the time of the accident, the aircraft was carrying a pilot and passenger in the front seats. A second passenger occupied the right hand seat in the second row of seats. Based upon the weight of the occupants and items recovered, the aircraft weight was determined to have been 3303 pounds at the time of the accident, 222 pounds below its maximum allowable weight. The aircraft's C.G. was also determined to have been within limits.

Stalls

The speed at which a stall occurs is related to the load factor of the manœuvre performed. The load factor is defined as the ratio of the load acting on the wings to its gross weight, and represents a measure of the stress (or load) on the structure of the aircraft. By convention, the load factor is expressed in *g* (the unit of measure for vertical acceleration forces) because of the perceived acceleration due to gravity felt by an occupant in an aircraft. In straight and level flight, lift is equal to weight, and the load factor is 1 *g*. In a banked, level turn, however, greater

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10 Letter from Acting Administrator Michael P. Huerta, U.S. Federal Aviation Administration (FAA) to National Transportation Safety Board (NTSB), dated December 13, 2013; re. NTSB Safety Recommendations A-12-021, A-12-022 and A-12-023

11 Ibid.

lift is required. It can be achieved, in part, by increasing the angle of attack (by pulling back on the elevator control), which increases the load factor. As the load factor increases with bank angle, there is a corresponding increase in the speed at which the stall occurs. As a result, steep turns are often accomplished with the addition of engine power to maintain or increase airspeed.

A stall that occurs as a result of a high load factor, such as bank angle greater than 30°, is called an accelerated stall. Accelerated stalls occur at higher airspeeds due to the increased load factor on the wing, are usually more severe than un-accelerated stalls, and are often unexpected. As an example, a stall from a 60 to 70° bank will result in rapid departure from controlled flight and a significant loss of altitude before recovery is possible.

An aircraft's stall speeds and stall handling characteristics are affected by the wings' (airfoils) cross-sectional shape. Accordingly, modification of the airfoil through the addition of a STOL kit or combination of kits will result in changes to the aircraft's original stall speeds and handling characteristics. Typically, the addition of a STOL kit will decrease stall speeds and improve aircraft handling at slower speeds. Consequently, air operators will often add STOL kits to improve an aircraft's ability to fly into and depart from shorter or more confined landing areas.

Stall warning systems

The stall warning system on the 1970 C-185E is a pneumatic type consisting of a calibrated air inlet on the leading edge of the left wing that is connected to an air-operated horn located inside the wing root near the upper left corner of the windshield. As the aircraft approaches an aerodynamic stall, low pressure occurs at the wing leading edge that draws air across a small reed, producing an audible sound. The stall warning system is calibrated to sound 5 to 10 knots above the actual stall speed.

An examination of the stall warning system on the accident aircraft confirmed the presence of all components and proper function of the reed. Due to damage to the wing leading edge, wing root and upper cabin areas, it was not possible to determine if the inlet was calibrated to sound the horn prior to an aerodynamic stall. The air operator could not recall ever having heard the stall warning sound in the accident aircraft.

The aircraft was not equipped with a linear stall warning device such as an angle-of-attack indicator (AOA), nor was it required to be. An AOA provides a pilot with continuous reference concerning the aircraft's angle of attack. As the aircraft stalls at a specific angle of attack, but at different airspeeds dependent on wing loading, AOAs provide more accurate predictions of stalls. An AOA is particularly effective during STOL operations when the aircraft is flown at speeds close to the critical angle of attack (where maximum lift occurs).[12]

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12 In 2014 the Federal Aviation Administration (FAA) issued InFO Letter 14010, Installation, Training, and Use of Non-required/Supplemental Angle-of-Attack (AOA) Based Systems for General Aviation (GA) Airplanes. The letter promotes the use of AOA systems in GA aircraft based upon studies conducted by the FAA General Aviation Joint Steering Committee Safety Assessment Team.

Stall characteristics of C-185 with Robertson Short Take-off and Landing kit

In 2003, following the crash[13] of a C-185F seaplane equipped with a Robertson STOL kit, the Finland Safety Investigation Authority conducted flight testing of a similarly equipped C-185 to determine the stall characteristics of a Robertson STOL-modified aircraft. During testing it was found that, just before an aerodynamic stall, initial airflow separation occurred at the ailerons when flaps were deployed either at 10 or 20 degrees and ailerons were drooped through the system's flap-aileron interconnect. This interruption in laminar flow resulted in degradation of roll control both prior to and during a stall.

It was also found that on an aircraft modified with the Robertson STOL kit, air-flow separation (with flaps lowered) began at the wing tips and progressed toward the wing root. This diminished the stabilizing effect of the aircraft's wing washout,[14] which resulted in an abrupt stall break. Consequently, the Finland Safety Investigation Authority recommended, "measures to inform pilots as comprehensively as possible about the stall behaviour of the Robertson STOL Cessna 185 aircraft".[15]

Flight path data

The GPS flight tracking data for the 2 flights flown by the pilot on the day of the accident were examined. Data from flights that day were compared to those from 4 previous flight segments flown in the aircraft by other company pilots.

The landing approaches from the 2 flights operated by the accident pilot showed that he had operated the aircraft at comparatively lower speeds and higher bank angles while manœuvring on approach. When making the final turn to landing at Port McNeill, the aircraft approached an angle of attack close to the aerodynamic stall found during the final turn at Potts Lagoon.

TSB Laboratory reports

The following TSB Laboratory report was completed:

- LP006/2014 Flight Path Analysis, Cessna 185 E C-FQGZ

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13 Finland Safety Investigation Authority, Investigation report B 2/2003 L Aircraft Accident at Enontekio, Finland, 25 June 2003

14 Washout is a feature of wing design that incorporates a lower angle of incidence at the wing tip than at the root. On wings constructed with washout, during flight at high angles of attack, airflow separation will occur first at the wing root area. This turbulent airflow results in some buffeting of the horizontal stabilizer and consequently provides the pilot some warning of an impending stall. In addition, the un-stalled ailerons remain effective, and the gradual separation of airflow results in a relatively gentler stall break.

15 Finland Safety Investigation Authority, Investigation report B 2/2003 L Aircraft Accident at Enontekio, Finland, 25 June 2003

Analysis

Examination of the airframe, engine, and propeller revealed no evidence of mechanical failure that would have contributed to the accident. The aircraft's high bank angle, steep descent, short wreckage trail, and low airspeed were consistent with the occurrence of an accelerated aerodynamic stall at an altitude from which recovery was not possible. Tree scarring and propeller damage indicate the engine was operating at a high power setting at the time of the occurrence. This analysis focuses on the factors leading to an accelerated aerodynamic stall.

The pilot flew low over Potts Lagoon prior to returning for the approach and landing. Once over the lagoon, the pilot was primarily limited to manœuvring the aircraft over the water, because of the tall trees and terrain. The low, 400- to 500-foot agl cloud ceiling further confined the manœuvring space. The pilot executed a tight left turn and exceeded the wing's critical angle of attack. This resulted in an accelerated stall. Propeller and tree damage indicate that while the pilot had attempted to recover control, insufficient altitude remained before the aircraft collided with terrain.

The pilot, though new to Air Cab and the accident aircraft, had experience in floatplane flying both as a commercial pilot and recreationally while flying his own aircraft. A number of aircraft that he had flown were similar in size and performance to the accident aircraft. However, the accident aircraft's combination of modifications resulted in performance and handling characteristics unique to the aircraft. Consequently, the actual stall speed of the aircraft remained unknown and could only be estimated. Furthermore, the combined modifications may have compromised the ability of the stall warning system to provide an indication of an impending stall. When the stall was entered, it occurred abruptly due to the aircraft's high wing loading in the turn. The abruptness was likely aggravated by the Robertson Short Take-off and Landing (STOL) kit. If multiple supplemental type certificates (STC) are installed without adequate guidance on how to evaluate and document the effects on aircraft handling and performance, there is an increased risk of accidents due to unknown aircraft performance.

Given the pilot's experience, the contrast between his handling of the aircraft and that of the other company pilots is consistent with a difference in each pilot's expectation or understanding of the aircraft's performance. Consequently, in the absense of concrete performance data or experience with the handling characteristics of the accident aircraft, due to its modifications, the pilot likely believed that the aircraft was capable of flight beyond its actual performance envelope.

Without the use of advanced stall warning systems such as angle-of-attack indicators (AOA), pilots have to rely on airspeed indications alone to determine safe manœuvring speeds and bank angles. This puts pilots and passengers at risk of stall accidents because the stall speeds change with flight loads. AOAs provide pilots with constant and accurate information of when a stall will occur. If advanced stall warning systems, such as AOAs, are not incorporated on aircraft, there is an increased risk of stall accidents.

Findings

Findings as to causes and contributing factors

1. The aircraft had several approved modifications that resulted in undocumented performance and handling characteristics.

2. The pilot's expectation of the aircraft's performance capabilities likely assumed a reduced stall speed that was based on unverified performance.

3. The aircraft experienced an accelerated aerodynamic stall while being flown at an altitude from which recovery was not possible before it collided with terrain.

Findings as to risk

1. If multiple supplemental type certificates are installed without adequate guidance on how to evaluate and document the effects on aircraft handling and performance, there is an increased risk of accidents due to unknown aircraft performance.

2. If advanced stall warning systems, such as angle-of-attack indicators, are not incorporated on aircraft, there is an increased risk of stall accidents.

Safety action

Safety action taken

Transportation Safety Board of Canada

On 18 November 2014, the Transportation Safety Board of Canada (TSB) issued Safety Advisory letter A13P0278-D3-A1 to Transport Canada explaining the value of angle-of-attack indicators in small aircraft.

Air Cab

Air Cab has begun emphasizing an awareness of aircraft modifications and their effect on aircraft handling during pilot initial and recurrent training.

As well, the company is in the process of implementing a G switch on its aircraft tracking system as a back-up to the aircraft's emergency locator transmitter (ELT), and the installation of a disconnect G switch on its aircraft batteries to reduce the risk of fire.

Safety concern

Supplemental type certificate compatibility and interaction

In this accident, the combination of modifications resulted in performance and handling characteristics unique to the occurrence aircraft. Consequently, the actual stall speed of the aircraft remained unknown and could only be estimated. Furthermore, the combined modifications may have compromised the ability of the stall warning system to provide an indication of an impending stall.

The modification of aircraft by supplemental type certificate (STC) is common in Canada as it often serves as a relatively inexpensive way to derive greater performance or utility from an aircraft. As most STCs are developed and tested against an otherwise unmodified aircraft, the STC developer can develop performance data relating to the effect of the modification. However, combining an STC with that of other STC developers may result in unknown aircraft performance.

In May 2012, the National Transportation Safety Board concluded in its safety recommendations A-12-21, A-12-22 and A-12-23 "… that multiple STCs installed on an airplane can adversely affect the airplane's performance and structure if the STCs are not properly analyzed for compatibility."[16]

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16 Letter from National Transportation Safety Board (NTSB) Chairman Deborah A.P. Hersman to Acting Administrator Michael P. Huerta, U.S. Federal Aviation Administration (FAA), dated May 24, 2012; re. NTSB Safety Recommendations A-12-21, A-12-22 and A-12-23

Transport Canada currently requires that the installer evaluate any combination of STCs and make the determination as to whether the combination of STCs is airworthy. However, there is no regulatory guidance for determining the extent or depth of this evaluation and how it should be performed and documented.

Most light aircraft in Canada, including those being commercially operated, are maintained by smaller approved maintenance organizations (AMO) with limited capability for aerodynamic testing or engineering evaluations. As a result, the certification for compatibility and interaction between STCs is often made after only limited evaluation.

Consequently, the Board is concerned that, if multiple STCs are installed without adequate guidance on how to evaluate and document the effects on aircraft handling, pilots may lose control of the aircraft due to unknown aircraft performance.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 09 February 2015. It was officially released on 27 February 2015.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

Appendices

Appendix A – Location of accident