Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT A17W0172

Loss of control and collision with terrain

Springbank Air Training College
Piper PA-34-200T Seneca II, C-GCCM
Calgary/Springbank Airport, Alberta, 0.8 nm S
26 October 2017

Canada

Transportation Safety Board of Canada
Place du Centre
200 Promenade du Portage, 4th floor
Gatineau QC K1A 1K8
819-994-3741
1-800-387-3557
www.tsb.gc.ca
communications@tsb.gc.ca

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Cat. No. TU3-5/17-0172E-PDF
ISBN 978-0-660-28445-3

This report is available on the website of the
Transportation Safety Board of Canada at www.tsb.gc.ca

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Summary

At 0949 Mountain Daylight Time on 26 October 2017, the Springbank Air Training College Piper PA-34-200T Seneca II (serial number 34-7570103, registration C-GCCM) departed from Runway 17 at Calgary/Springbank Airport (CYBW), Alberta, with a student pilot and flight instructor on board. The purpose of the flight was to conduct a multi-engine training flight to the practice area. Approximately 70 seconds after takeoff and 0.8 nautical miles south of Runway 17, the aircraft rolled to the left, entered a steep, descending left turn, and collided with terrain. There was a post-impact fire, and the aircraft was destroyed. The 2 occupants were fatally injured. The 406 MHz emergency locator transmitter did not activate. Motorists on the nearby Trans-Canada Highway who witnessed the accident arrived on scene in less than 1 minute.

Le présent rapport est également disponible en français.

Factual information

History of the flight

On 26 October 2017, a flight instructor from Springbank Air Training College (SATC) was scheduled to conduct a pre–flight test evaluation of an SATC student pilot at Calgary/Springbank Airport (CYBW), Alberta, prior to the student pilot's attempting the actual flight test for his multi-engine rating. The flight was therefore being conducted with a different flight instructor than the one who had completed the majority of the student's multi-engine training.

The Piper PA-34-200T Seneca II (serial number 34-7570103, registration C-GCCM) had originally been booked for the exercise from 0800[1] to 1000 on 26 October 2017. The examining instructor arrived at the hangar at approximately 0900 and met with the student. The instructor then conducted a pre-flight briefing with the student and the evaluation began.

At 0933:50, clearance for taxi and engine run-up was requested.

At 0948:30, the student pilot resumed taxiing to Runway 17. At 0948:41, he acknowledged the take-off clearance.

Based on wide-area multilateration (WAM) surveillance data obtained from NAV CANADA, at 0949:40, the aircraft lifted off from Runway 17 at an estimated airspeed of 80 knots calibrated airspeed (KCAS) and began an initial climb on the runway heading. The landing gear was then retracted. The aircraft reached a peak airspeed of 90 KCAS about 15 seconds after liftoff. A maximum height of 250 feet above ground level (AGL) was achieved about 40 seconds after takeoff. However, by that time, the airspeed had decreased to 70 KCAS and the aircraft's track was 10° to the left of the extended runway centreline. The aircraft then moved back toward the centreline and continued moving until it was about 5° to the right of the extended runway centreline.

The aircraft continued for another 30 seconds, with an average descent rate of 200 feet per minute (fpm) and an airspeed of just under 70 KCAS. During this time, the flight instructor made a request to Springbank Control Tower to conduct a circuit right away. No emergency or abnormal situation was declared.

The aircraft then entered a tight descending and rolling left turn approximately 300 feet north of hydroelectric power lines that were running in an east–west direction. The estimated airspeed dropped to about 65 KCAS when the aircraft was at an altitude of about 100 feet AGL (Figure 1 and Figure 2).

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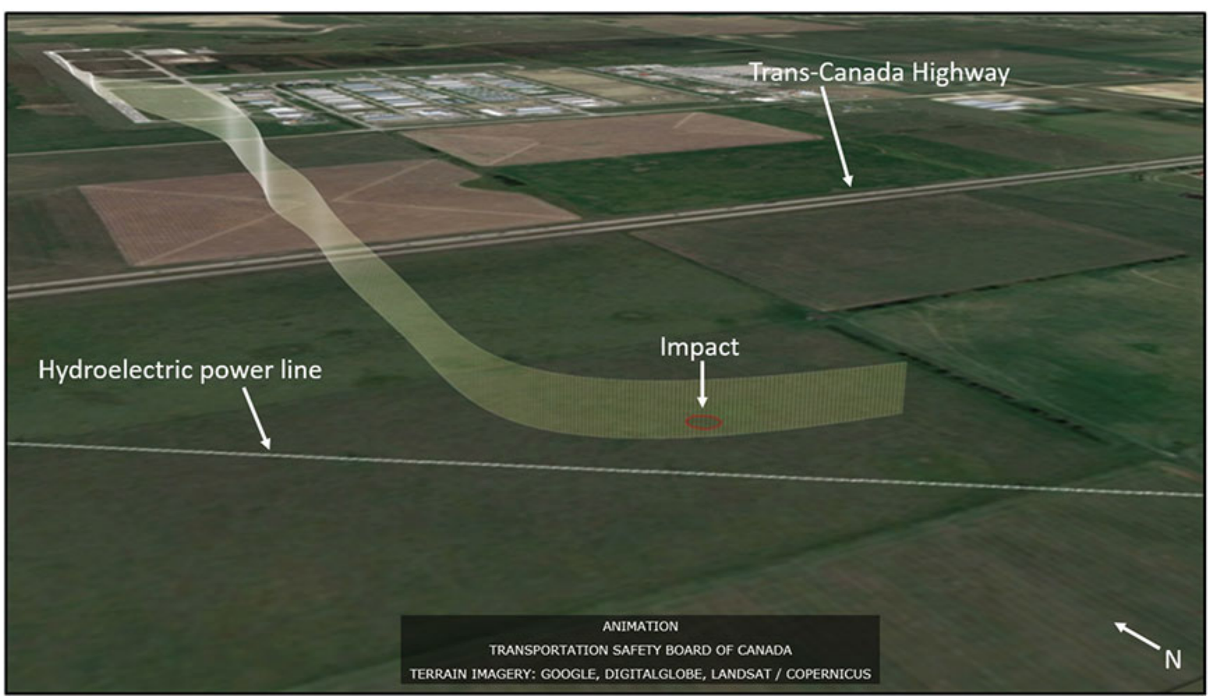
[1] All times are Mountain Daylight Time (Universal Coordinated Time minus 6 hours).

Figure 1. Overhead depiction of the occurrence aircraft's flight path based on NAV CANADA wide-area multilateration data (Terrain imagery sources: Google Earth, DigitalGlobe, and Landsat/Copernicus, with TSB annotations)

Figure 2. Screen capture of the occurrence aircraft's flight path based on a TSB Engineering Laboratory animation of smoothed wide-area multilateration data—view to the northeast (Terrain imagery sources: Google, DigitalGlobe, and Landsat / Copernicus, with TSB annotations)



At 0951:10, the aircraft collided with terrain approximately 0.8 nautical miles (nm) south of Runway 17. Both occupants received fatal injuries. The aircraft was destroyed, and there was an intense post-impact fire. The 406 MHz emergency locator transmitter did not activate.

Motorists who witnessed the accident while driving on the Trans-Canada Highway under the aircraft's flight path arrived on scene less than 1 minute after the crash.

Wreckage and impact information

The wreckage was situated 0.8 nm south of the departure end of Runway 17, on the south side of the Trans-Canada Highway, in pastureland at an elevation of 3918 feet above sea level (ASL). Following the impact sequence, the aircraft wreckage came to rest on a heading of 183° magnetic (M). Eyewitness accounts, ground scars, and aircraft damage indicated that the impact occurred in a near-vertical attitude.

All of the aircraft's major components were accounted for at the accident site. Examination of the wreckage determined that there was no evidence of pre-impact failure of the flight control system or airframe. The post-impact fire destroyed the aircraft's avionics and engine instrumentation. The majority of the aircraft was consumed by fire, with the exception of the empennage and the outboard portions of the left and right wings.

Both propellers were located at the initial impact site, approximately 10–12 inches under the ground in a horizontal position, with the propeller mounting flange broken off of both engines' crankshafts. The propeller blades were found in a low-pitch condition. Based on the impact signatures and markings on the engines and propellers, it was determined that both engines were producing low power at the time of impact.

An initial examination of the engines at the scene did not reveal any obvious signs of failure. The airframe, engines, and propellers were transported to the TSB facility in Edmonton, Alberta, for detailed examination.

Both engines, propellers, and turbo chargers were completely disassembled at the TSB facility in Edmonton by TSB investigators, with the assistance of the manufacturers' safety investigators. No evidence of pre-impact failure was found, nor were there any indications of issues that would have prevented the systems from operating normally.

The airframe was examined to the extent possible, and it was confirmed that the landing gear was in the retracted position, the flaps were up, and the flight control system showed no indications of pre-impact failure. The fuel selector valves are cable-actuated, and there is 1 in each wing; they were examined at the TSB Engineering Laboratory in Ottawa, Ontario. Due to the impact sequence of the airframe and post-impact fire damage, no conclusions could be made regarding their position or condition prior to impact.

The aircraft had been fuelled to its maximum capacity of 123 U.S. gallons at SATC the day before the occurrence flight. A fuel sample was taken from the SATC fuel supply and sent for analysis. The analysis confirmed that the fuel sample met the specifications required for 100LL aviation gasoline. All of SATC's aircraft are refuelled from this tank, and no other aircraft operated by SATC had experienced any fuel-related operational abnormalities before or after the date of the occurrence.

Meteorological information

At the time of the accident, the southern portion of Alberta was under the influence of a high-pressure system roughly centred over Nanton, Alberta. The graphical area forecast[2] issued at 0531 on the day of the occurrence, and valid from 0600 to 1159, called for clear sky conditions with local visibilities of 0.5 statute miles (sm) in freezing fog. No significant turbulence or icing conditions were forecast for the CYBW area. The density altitude was calculated at 2238 feet ASL at the time of the accident.

The aerodrome routine meteorological report (METAR) for CYBW issued at 0900 indicated the following:

- Winds: 150° true (T) at 14 knots
- Visibility: 9 sm
- Scattered clouds at 21 000 feet ASL
- Temperature: −5 °C, dew point −6 °C
- Altimeter setting: 30.31 inHg

The METAR for CYBW issued at 1000 indicated the following:

- Winds: 160°T at 12 knots
- Visibility: 9 sm
- Skies overcast at 20 000 feet ASL
- Temperature: −4 °C, dew point −5 °C
- Altimeter setting: 30.27 inHg

Aircraft information

The Piper PA-34-200T Seneca II is a low-wing, all-aluminum aircraft. It is equipped with 2 Continental turbocharged engines—an LTSIO-360 and a TSIO-360—and retractable landing gear. The aircraft design incorporates counter-rotating engines to eliminate critical engine[3] considerations.

At the time of the accident, SATC was operating 2 Seneca II aircraft. The occurrence aircraft was the most recent addition to the fleet. The aircraft had been purchased earlier in 2017 from the United States and registered with Transport Canada (TC) on 07 July 2017. The import was completed on 03 August 2017.

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2 NAV CANADA, GFACN32 CWAO, Prairies Region, Clouds and Weather.

3 The critical engine is the engine that, if inoperative, would most adversely affect the performance or handling qualities of an aeroplane. (Source: Transport Canada, TP 11575, *Instructor Guide: Multi-Engine Class Rating*, Second Edition [October 2010], Definitions: Common Terms, p. 3.)

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The most recent 100-hour-interval inspection was completed on 03 August 2017. The aircraft was operating within the approved weight-and-balance envelope during the flight, at a take-off weight of 4226 pounds.

The aircraft was equipped with a vortex generator kit in accordance with supplemental type certificate (STC) SA00109SE. The vortex generators were installed on the wings and vertical stabilizer to provide the option of reducing the minimum control airspeed (V_{MC}) to 63 KCAS. However, given the flight-training environment, SATC elected to operate under the higher V_{MC} published on the original type certificate, which was 70 KCAS. This 7-knot difference in airspeed allowed for a safety margin.

The stall speed for the aircraft at 4250 pounds, wings level, flaps up, and landing gear retracted is 63 KCAS.[4]

The aircraft was not equipped with a cockpit voice recorder (CVR) or flight data recorder (FDR), and neither was required by regulation.

Table 1. Aircraft information

Manufacturer	Piper Aircraft Corporation
Type, model and registration	PA-34-200T Seneca II, C-GCCM
Year of manufacture	1975
Serial number	34-7570103
Certificate of airworthiness	08 August 2017
Total airframe time	3915.5 hours
Engine type (number of engines)	Teledyne Continental TSIO/LTSIO 360-E (2)
Propeller (number of propellers)	Hartzell PHC-C3YF-2KUF/2LKUF (2)
Maximum allowable take-off weight	4750 pounds
Recommended fuel type	100/130 aviation gasoline
Fuel type used	100LL aviation gasoline

Personnel information

General

Records indicate that the instructor and the student were certified and qualified for the flight in accordance with existing regulations. The investigation determined that there was nothing to indicate that the performance of the pilots was degraded by physiological factors.

4 Piper Aircraft Corporation, *Airplane Flight Manual for Seneca II*, Model: PA-34-200T (FAA Approved 09 March 1984), Section 9: Performance Charts.

Table 2. Personnel information

	Instructor	Student
Pilot licence	Commercial pilot licence	Private pilot licence
Medical expiry date	01 June 2018	01 April 2022
Total flying hours	2167.0	175.6
Flight hours on type	141.5	5.7
Flight hours in the last 7 days	0	1.7
Flight hours in the last 30 days	23.2	10.2
Flight hours in the last 90 days	37.5	29.2
Flight hours on type in the last 90 days	30.0	5.7
Hours on duty prior to the occurrence	1	2
Days off duty prior to the work period	14	5

Instructor

The instructor had been employed by SATC since 23 May 2012. He possessed a commercial pilot licence with multi-engine and class 3 instructor ratings and a valid class 1 medical. At the time of the accident, the instructor had accumulated 2167 hours total flight time, 175 of which were logged as multi-engine time, and 141.5 on the Seneca II. He had 1050 hours as an instructor. His last Piper Seneca II evaluation flight by SATC was in January 2017.

Student

The student had started his flight training with SATC on 09 March 2016 and obtained his student pilot permit on 13 May 2016. At the time of the accident, he held a private pilot licence and a valid class 1 medical. He had accumulated 175.6 hours total flight time. The student pilot had successfully completed the commercial pilot flight test on 03 August 2017, but he had not yet acquired the 200 hours total flight time required to obtain a commercial pilot licence. The student pilot had accumulated 5.7 hours on the Seneca II toward obtaining a multi-engine rating.

Organizational and management information

Springbank Air Training College

SATC is a TC-authorized flight-training unit that holds a valid flight training unit operator certificate under Subpart 406 of the *Canadian Aviation Regulations* (CARs). It was founded in 1999 and is based out of, and operates from, CYBW. It provides training required to obtain Canadian pilot licences and ratings. At the time of the occurrence, in addition to the 2 Seneca II aircraft, the training fleet consisted of several Cessna 172s and a Cessna 182.

Springbank Air Training College manuals and procedures

Prior to 02 October 2017, SATC's standard operating procedures (SOPs), flight operations manual (FOM), and training manual were combined in 1 document.[5]

With respect to training exercises to practise engine failures, the document specified the following:

> Engine failures in cruise and the overshoot are to be practised at a height of at least 2500 ft AGL. Engine failures in the circuit and approach are at the discretion of the instructor.[6]

However, the investigation found that SATC instructors were also using guidance provided in 2 related TC publications.[7,8] These guidance documents indicated that the lowest recommended altitudes for training and testing of simulated engine failure on takeoff or overshoot are 500 feet AGL and 2000 feet AGL, respectively.

On 02 October 2017, SATC issued a new set of documents that separated the previously combined manuals. A flight-training operations manual (FTOM) and new SOPs were created. In addition, 3 separate SOPs were put in place to reflect each of the aircraft types operated by the school. One of these was for the Seneca II. The PA-34 SOPs had been formalized with multi-engine instructors who were included in the SOPs' design and publication, as well as in group sessions.

An email was sent out informing those operating SATC aircraft that the new documents were in effect. All users were required to read the new documents and sign a statement to that effect. Both pilots on the occurrence flight had signed the statement.

The only guidance with respect to altitudes for the safe conduct of simulated emergencies contained in the new FTOM was the following: "Instructors should use discretion when conducting such scenarios [...]."[9]

The new Seneca SOPs contained the following guidance with respect to altitudes for the safe conduct of simulated emergencies: "Simulated engine failure can be initiated anywhere above 500 [feet] AGL."[10] It also addressed simulated engine failures in cruise or on approach. It did not contain instructions for simulated engine failures on takeoff.

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5 Springbank Air Training College, Standard Operating Procedures: Multi-Engine & IFR Training—PA-34-200T, Revision 2 (11 November 2015).

6 Ibid., p. 23.

7 Transport Canada, TP 11575, *Instructor Guide: Multi-Engine Class Rating*, Second Edition (October 2010), exercise 10, p. 37.

8 Transport Canada, TP 219, *Flight Test Guide: Multi-Engine Class Rating – Aeroplane*, Ninth Edition April 2017), p. 27.

9 Springbank Air Training College, *Flight Training Operations Manual*, Revision 1.1 (02 October 2017), section 2.6.1, p. 61.

10 Springbank Air Training College, *PA-34-200T Standard Operating Procedures*, Revision 1.1 (01 October 2017), section 2.7.5, p. 70.

Multi-engine flight training program

Students of SATC's multi-engine flight training program undergo 11 multi-engine lesson plans (MELPs) involving a cumulative 12.8 hours of dual flight time in the Seneca II and 8.2 hours of ground briefings. In addition, approximately 2 further hours of combined ground and flight time are required to complete the multi-engine flight test examination.

The occurrence flight was MELP 11, which was a simulated multi-engine flight test with an instructor other than the student's usual instructor. This would normally be the last lesson before the actual flight test. The FTOM in effect at the time contained a MELP 11 syllabus that listed engine-failure exercises during cruise, overshoot, and approach and landing only. There was no documentation at TC or SATC that mentioned practising or testing single-engine failures during takeoff.

The investigation found that the occurrence instructor had conducted simulated engine failures on takeoff in at least 2 instances. On those occasions, the simulated engine failure was performed just after the landing gear had been retracted; typically, the aircraft would have been at an altitude of 100 to 200 feet AGL at the time.

Procedures and performance

General

According to the Piper PA-34-200T pilot's operating manual, and based on the weight of the aircraft and the atmospheric conditions at the time of the occurrence, the aircraft would have required 850 feet for the take-off roll, and 1160 feet to clear a 50-foot obstacle.[11]

The climb performance for the aircraft at gross take-off weight and in the atmospheric conditions at the time of the occurrence would have been 1280 fpm for a 2-engine climb, and 210 fpm for a single-engine climb.[12]

Springbank Air Training College normal take-off and climb procedure

SATC's SOPs for the PA-34-200T describe the following power setting for a normal climb:

> At altitudes below 12,000 feet, normal takeoffs are made with less than full throttle. Use throttle only as required to obtain 35 [inches] MP [manifold pressure]. DO NOT EXCEED 40 [inches] MP.[13]

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11 Piper Aircraft Corporation, *The Seneca II Pilot's Operating Manual* (issued 15 July 1974), Section 9: Performance Charts.

12 Ibid.

13 Springbank Air Training College, *PA-34-200T Standard Operating Procedures*, Revision 1.1 (01 October 2017), section 2.5: Takeoff, p. 64.

The SOPs also state the following for a normal climb:

> Above 400 [feet] AGL or clear of obstacles, whichever is higher, normal climbs are accomplished with the flaps up and climb power (31.5 [inches] MP and 2450 RPM) at an airspeed of 102 KIAS [knots indicated airspeed]. This provides the best combination of aircraft performance, engine cooling and visibility. When establishing in a climb at any point throughout a flight, the Pilot Flying shall always apply power in the following order: Mixture, Propeller and Power.[14]

Airspeed definitions

TC's *Instructor Guide: Multi-Engine Class Rating* (TP 11575) contains the following definitions related to multi-engine aircraft operations:

> V_{MC} *Minimum Control Speed* - the minimum flight speed at which it is possible to retain control of the aeroplane and maintain straight flight, through the use of maximum rudder deflection and not more than 5 degrees of bank, following sudden failure of the critical engine.
>
> NOTE 1: V_{MC} for an aeroplane type is generally determined under the following conditions:
>
> - all engines developing maximum rated power at the time of critical engine failure
> - the aeroplane at a minimum practical weight and with a rearmost centre of gravity; and
> - landing gear retracted, flaps in take-off position and the propeller of the critical engine windmilling.
>
> NOTE 2: At speeds below V_{MC}, the aeroplane will yaw and roll towards the failed engine. It cannot be too strongly emphasized that control will be regained only by a reduction in power of the good engine or by increasing airspeed through a change in pitch attitude, or both.
>
> Refer to AC 23-8B – *Flight Test Guide for Certification of Part 23 Airplanes* at the following website: http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/MainFrame?OpenFrameSet [...]
>
> V_{SSE} *Intentional One Engine Inoperative Speed* - a speed above both V_{MC} and the stall speed, selected to provide a margin of lateral and directional control when one engine is suddenly rendered inoperative. An intentional failing of one engine below this speed [is] not recommended. [...]

[14] Ibid., section 2.6.2: Normal Climb Profile, p. 65.

V_{YSE} -*One Engine Inoperative Best Rate-of-Climb Speed* - the speed that provides the maximum foot-per-minute altitude gain with one engine inoperative.[15]

Minimum control speed (V_{MC}) roll

A V_{MC} roll is a rapid roll at an airspeed below V_{MC}. It occurs due to insufficient yaw control available to counter the thrust produced by the operating engine. A sudden application of power on the operating engine accelerates any imminent V_{MC} roll condition. At that point, the airplane quickly rolls toward the non-operating engine.

Engine failure procedures

The airplane flight manual (AFM) contains the following emergency procedure to feather the propellers if an engine failure occurs in flight and it is not appropriate to restore power:

a. Minimum control speed – 80 MPH [V_{MC} 70 KCAS]

b. Best R/C [rate of climb] speed single engine – 105 MPH [V_{YSE} 91 KCAS]

c. Maintain direction and airspeed above 90 MPH [V_{SSE} 78 KCAS]

d. Mixture controls – forward

e. Propeller controls – forward

f. Throttle controls – forward (not to exceed 40 inches manifold pressure)

g. Flaps – retract

h. Gear – retract

i. Identify inoperative engine

j. Throttle of inoperative engine – retard to verify

k. Mixture of inoperative engine – idle cut off

l. Propeller of inoperative engine - feather[16]

The AFM also contains the following emergency procedure if an engine failure occurs during the climb:

a. If engine failure occurs when airspeed is below 80 mph (CAS) [calibrated airspeed] [70 KCAS] reduce the power on the operating engine as required to maintain directional control. Reduce nose attitude to accelerate toward the single engine best rate of climb speed of 105 mph [91 KCAS]. Then feather inoperative engine (see feathering procedure).[17]

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15 Transport Canada, TP 11575, *Instructor Guide: Multi-Engine Class Rating*, Second Edition (October 2010), Definitions: Applicable Speeds, pp. 2–3.

16 Piper Aircraft Corporation, *Airplane Flight Manual for Seneca II*, Model: PA-34-200T (FAA Approved 09 March 1984), Section II: Procedures, C. Emergency Procedures, 2. Feathering Procedure, p. 12.

17 Ibid., 7. Engine Failure During Climb, p. 15.

SATC's SOPs for the PA-34-200T described the following procedure for an engine failure after takeoff:

> Maintain directional control with rudder, and bank towards the good engine. Ensure you have max power on the good engine (40 [inches] MP). Identify and verify the failed engine and complete the drill as soon as possible. There will be a considerable amount of drag produced by the windmilling engine. The sooner the propeller is feathered the better the aircraft will climb. The drill needs to be completed immediately; however, nothing else shall be done until you are above 400 [feet] or obstacle clearance whichever is higher. Once above 400 [feet] or obstacle clearance you should advise ATC [air traffic control] of the emergency and ask them to stand by. Once at a safe altitude (approx. 1000 ft AAE [above aerodrome elevation]) complete the checklist and advise ATC.[18]

For simulated single-engine exercises the "failed" engine is set to 1900 rpm and 19 inches of manifold pressure to emulate a feathered propeller condition.

Wide-area multilateration surveillance data analysis

General

The TSB Engineering Laboratory conducted an analysis of NAV CANADA's WAM surveillance data for the occurrence flight. WAM data is produced by equipment that provides aircraft positional information, similar to radar data, to air traffic controllers. The analysis was repeated using the WAM data for a previous flight conducted by the occurrence aircraft on 21 October 2017. The results from both flights were then plotted together for comparison (Appendix A). However, the limitations of the radar surveillance produce a large margin of error.

Comparison takeoffs

A comparison of the occurrence takeoff with the takeoff of the earlier flight (21 October) suggests a substantial difference in performance. The initial climb airspeed on this flight was about 25% higher than the occurrence flight (100 KCAS versus 80 KCAS) and remained at that airspeed, whereas the occurrence flight's speed began to fall toward 70 KCAS.

The peak climb rate on the earlier flight was nearly triple that of the occurrence flight (1100 fpm versus 400 fpm), after which it climbed at approximately 700 fpm. In contrast, the occurrence flight was losing altitude at a rate of 200 fpm—a relative deficit of about 900 fpm.

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18 Springbank Air Training College, *PA-34-200T Standard Operating Procedures*, Revision 1.1 (01 October 2017), section 3.5.1: Engine Failure After Takeoff, p. 80.

The analysis was repeated using the global positioning system (GPS) data for takeoffs conducted on the other SATC Seneca II, which took place on 17 and 22 March 2018.[19] The comparison data showed take-off speeds comparable to those on the occurrence flight. The other Seneca II demonstrated a higher climb rate, which ranged between 500 fpm and 1000 fpm, and eventually stabilized at about 600 fpm. The flight on 22 March 2018 showed even higher climb rates.

The occurrence flight's relatively low initial climb rate suggests that the thrust was below normal levels. The occurrence flight's estimated total power following takeoff was much lower than that of the comparison flights—as low as ⅓.

Peak altitude and descent comparison

The estimated power for the occurrence aircraft's earlier flight and the 2nd SATC Seneca II's flights remained relatively steady as the aircraft continued their climbs, whereas the estimated power for the occurrence flight decreased toward minimum level within about 30 seconds of takeoff, and remained at that level until the eventual collision with terrain.

During the occurrence flight, the aircraft settled into a steady descent from a peak height of about 250 feet AGL, averaging 70 KCAS and reducing to about 65 KCAS in the turn, with a descent rate of 200 fpm. This indicates a descent ratio of about 35:1. This estimated ratio is considerably higher than what would normally be expected for this type of aircraft if it were descending with zero thrust (gliding), which may suggest that the aircraft was still producing some thrust (Appendix A).

The estimated speed during the turn was at or below the V_{MC} published in the AFM (70 KCAS), and would have left little or no margin above the V_{MC} published in the flight manual supplement for the installed STC (63 KCAS).

TSB recommendation on flight recorders

In an occurrence investigated by the TSB,[20] a privately operated Mitsubishi MU-2B-60 aircraft struck terrain on its final approach to Îles-de-la-Madeleine Airport, Quebec. All 7 occupants were fatally injured. A lightweight FDR system was on board the occurrence aircraft, although it was not required by regulation. The recovery of the recorder and the extraction of its data for analysis gave the investigation a better understanding of the sequence of events that led to the aircraft's departure from controlled flight. Had a recording system not been on board, crucial information to understand the circumstances and events leading up to this occurrence would not have been available to the investigation.

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19 For the takeoff conducted on 17 March 2018, the reported winds were 2 knots from 300°T, and the altimeter setting was 29.79 inHg. On 22 March 2018 the reported winds were 12 knots from 100°T, and an altimeter setting of 29.79 inHg.

20 TSB Aviation Investigation Report A16A0032.

In contrast, another occurrence investigated by the TSB[21] involved a privately operated Cessna Citation 500 that lost control and struck the ground, fatally injuring all 4 occupants. Because the occurrence aircraft was not equipped with any type of FDR or CVR, the lack of flight data prevented investigators from fully identifying and understanding the sequence of events and the accident's underlying causes and contributing factors. The investigation could not determine why the aircraft departed controlled flight and collided with terrain.

The Cessna Citation 500 investigation concluded that there is compelling evidence that the lack of recording devices on board commercial aircraft and private aircraft operated under CARs Subpart 604 continues to impede the TSB's ability to advance transportation safety. Therefore, the Board recommended that

> the Department of Transport require the mandatory installation of lightweight flight recording systems by commercial operators and private operators not currently required to carry these systems.
>
> **TSB Recommendation A18-01**

In its response to Recommendation A18-01, TC indicated that it agrees in part with Recommendation A18-01, and that it would undertake a policy analysis of flight data management. Two approaches have been identified:

- the voluntary installation of FDRs and lightweight data recorders (LDRs), as well as the publication of an advisory circular and guidance to operators
- the possible introduction of regulations for the installation of FDRs and LDRs into newly manufactured aircraft. TC indicated that the sectors of Canadian aviation that would be subject to this certification requirement are yet to be determined. TC also indicated that all certification requirements will be, at minimum, fully aligned with ED155, the European Organisation for Civil Aviation Equipment Minimum Operational Performance Specification for lightweight flight recording systems, referenced in International Civil Aviation Organization Annex 6.

TC indicated that it will re-evaluate these 2 approaches by further assessing the number of operators that have voluntarily adopted flight data monitoring systems. Consideration would be given to other measures, including a regulatory solution, if the results of the voluntary approach prove insufficient.

TC intends to continue to engage and collaborate with industry to develop recommended practices and determine key obstacles in the adoption and installation of flight data systems.

In addition to TC's response, the TSB received information from the Canadian Business Aviation Association (CBAA) regarding actions taken following the publication of Recommendation A18-01. In its letter, the CBAA informed the TSB that it will continue to promote FDR fitment and analysis of data derived from the FDR through the CBAA Partners-in-Safety Program. Additionally, the CBAA has signed an agreement with a supplier to provide CBAA members with flight data analysis services. Finally, the CBAA

[21] TSB Aviation Investigation Report A16P0186.

informed the TSB that it will support a regulatory approach requiring FDRs on private aircraft, if supported by a cost–benefit analysis. However, it noted that the retrofitting of business aircraft may not always be possible due to cost and technical constraints.

The Board appreciates that TC is committed to working with industry to promote the voluntary installation of FDRs and LDRs for Canadian aircraft that fall outside the scope of the current CARs requirements. However, no specific timeline has been provided for the proposed actions. Although the proposed actions could mitigate the risk once implemented, until TC provides the TSB with a more detailed plan of action for moving forward, it is unclear when or to what extent the safety deficiency identified in Recommendation A18-01 will be addressed.

Therefore, the response to Recommendation A18-01 is assessed to be **Satisfactory in Part**.

The SATC Seneca II accident highlights the importance of recorded information in determining what caused an accident.

TSB laboratory reports

The TSB completed the following laboratory report in support of this investigation:

- LP009/2018 – Radar Data Analysis

Analysis

The aircraft was destroyed by the crash and subsequent post-impact fire; therefore, it could not be determined whether any pre-impact system failure or malfunction contributed to the accident. However, the components that were examined showed no signs of malfunction.

No 406 MHz emergency locator transmitter signal was detected. Due to the post-impact fire damage, the investigation could not determine the reason for this.

Because there was no flight data or cockpit voice recorder available to the investigation, it was not possible to determine the actions of the crew or a precise cause of the accident. The analysis will focus on the aircraft's performance during the take-off phase of flight and possible scenarios for the departure from controlled flight and the collision with terrain.

Simulated engine failure scenario

After the aircraft took off, it did not follow the normal climb profile for multi- or single-engine operation and ultimately began to descend. The 1-engine-inoperative best rate-of-climb airspeed (V_{YSE}) was achieved, but only momentarily, and slowly decreased to the minimum control airspeed (V_{MC}).

The radar track showed the aircraft deviating to the left of the extended runway centreline, which is consistent with a power reduction on the left engine. The radar track also showed that the aircraft returned toward the extended runway centreline, which indicates that there was some degree of controllability of the aircraft.

Despite the limited information available to the investigation, there was enough to indicate that the likely scenario leading up to the loss of control was an intentional simulated engine failure. This is supported by the following facts:

- The pre-flight-test evaluation was to include various engine failure scenarios, including an engine failure during cruise, overshoot, and approach and landing.
- The flight instructor had conducted simulated engine failures shortly after takeoff on training flights in the past.
- The aircraft lacked climb performance.
- The radar track showed the aircraft deviating to the left of the extended runway centreline, which is consistent with a power reduction on the left engine.
- Neither pilot declared an emergency or abnormal situation to the Springbank Control Tower.
- The technical examination of both engines did not reveal any pre-impact failure modes that would have prevented them from producing optimum power.

Stall scenario

A stall scenario was considered, given that the stall speed and the V_{MC} speed for the configuration of the aircraft were the same, at 63 knots calibrated airspeed (KCAS); however, the characteristics of the final stages of the occurrence flight were consistent with the flight entering into a V_{MC} roll rather than an aerodynamic stall. More specifically,

- the initial track after takeoff deviated to the east, indicating a probable left-engine failure simulation resulting in an asymmetric power situation;
- there was a lack of damage to the propeller blades and the low-power indications; and
- wreckage information, eyewitness statements, and wide-area multilateration data analysis indicate that the aircraft entered a sudden, steep bank or roll in a nose-down attitude.

Response to simulated engine failure

The lack of climb performance and reduction in airspeed are consistent with maximum continuous power not being set on the operating engine. Springbank Air Training College's normal take-off procedure uses a reduced power setting of 35 inches of manifold pressure, and, shortly after landing gear is selected up and a climb is established, power is further reduced to 31.5 inches of manifold pressure. If an engine failure occurs or is simulated at this time, power would have to be increased on the operating engine to 40 inches of manifold pressure to obtain a positive rate of climb and to maintain V_{YSE}.

The emergency procedure for an engine failure requires the pilot to maintain directional control, configure the aircraft for maximum continuous power, and reduce drag by retracting the flaps, retracting the landing gear, and feathering the propeller. In the case of an exercise, the emulation of feathering would be achieved by setting 1900 rpm and 19 inches of manifold pressure on the "failed" engine.

It is likely that a left-engine failure on takeoff was being simulated. It appears that, during this exercise, the maximum power was not set on the right engine to enable the aircraft to achieve the 1-engine-inoperative best rate-of-climb airspeed (V_{YSE}) and a positive rate of climb. The investigation could not determine why maximum power would not have been set.

For unknown reasons, the airspeed decayed below the intentional 1-engine-inoperative speed (V_{SSE}) to V_{MC}, and the aircraft departed controlled flight and collided with terrain.

The lack of damage to the propeller blades and the low-power indications throughout the engines are consistent with the engines being at low power at the time of impact. The initial action for a recovery from a V_{MC} roll is to bring the power to idle.

The asymmetric power condition with the simulated left-engine failure at V_{MC} would have resulted in a V_{MC} roll at a height from which the pilots would have been unable to recover before impact with the terrain.

If simulated engine failures are conducted at low altitudes, there is a risk that pilots will be unable to recover in the event of a loss of control.

Findings

Findings as to causes and contributing factors

1. It is likely that a left-engine failure on takeoff was being simulated. It appears that, during this exercise, the maximum power was not set on the right engine to enable the aircraft to achieve the 1-engine-inoperative best rate-of-climb airspeed (V_{YSE}) and a positive rate of climb. The investigation could not determine why maximum power would not have been set.

2. For unknown reasons, the airspeed decayed below the intentional 1-engine-inoperative speed (V_{SSE}) to the minimum control airspeed (V_{MC}) and the aircraft departed controlled flight and collided with terrain.

3. The asymmetric power condition with the simulated left-engine failure at V_{MC} would have resulted in a V_{MC} roll at a height from which the pilots would have been unable to recover before impact with the terrain.

Findings as to risk

1. If simulated engine failures are conducted at low altitudes, there is a risk that pilots will be unable to recover in the event of a loss of control.

Safety action

Safety action taken

Springbank Air Training College

In December 2017, Springbank Air Training College published updated standard operating procedures (SOPs)[22] that specified

- minimum initiation altitudes for simulated engine failure exercises;
- procedures for simulated engine failure after takeoff; and
- procedures for simulated single-engine failure on approach.

The SOPs also specify the minimum altitudes at which various engine failure simulations may be initiated (Table 3).

Table 3. Springbank Air Training College updated SOPs specifying minimum initiation altitudes for various simulated engine failure exercises

Simulated engine failure exercise	Minimum initiation altitude (feet above ground level)
Engine failure in circuit (downwind and approach)	500
Engine failure in climb	1500
Engine failure after takeoff	3000
Engine failure in overshoot	3000
Minimum control speed (V_{MC}) demonstration	3500

Source: Springbank Air Training College, *PA-34-200T Standard Operating Procedures*, Revision 1.2 (effective 13 December 2017), p. 74.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 15 November 2018. It was officially released on 21 November 2018.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. 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.

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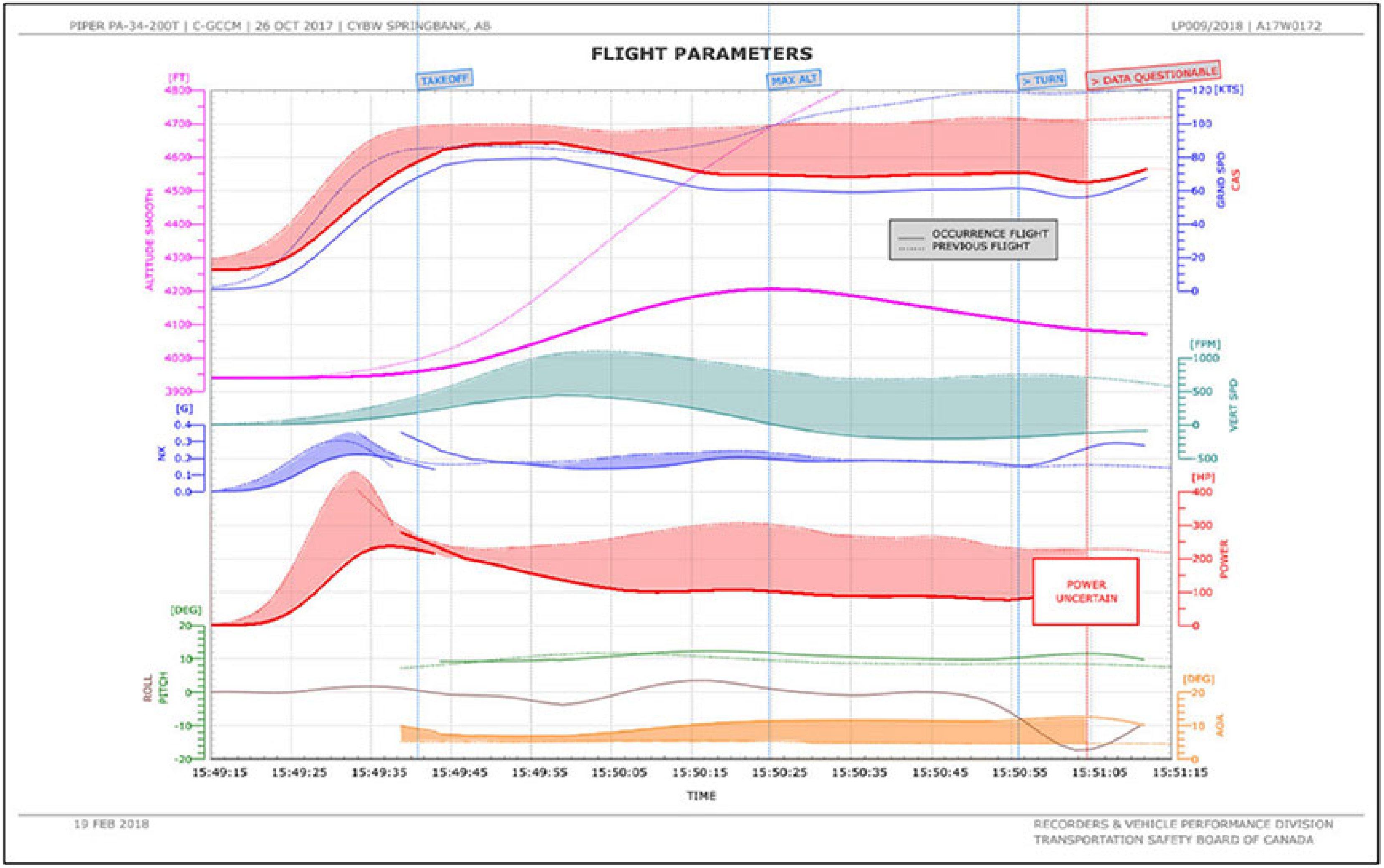
22 Springbank Air Training College, *PA-34-200T Standard Operating Procedures*, Revision 1.2 (effective 13 December 2017).

Appendix A – Comparison of flight data



Comparison of estimated flight parameters for the occurrence aircraft based on wide-area multilateration data. The occurrence flight is depicted by a solid line and the previous flight by a dotted line; the difference between the 2 is the tinted area.