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

Air Transportation Safety Investigation Report A19P0176

LOSS OF CONTROL AND COLLISION WITH TERRAIN

Privately registered
Piper Aerostar PA-60-602P, C-FQYW
Gabriola Island, British Columbia
10 December 2019

History of the flight

On 09 December 2019, a private Piper Aerostar PA-60-602P aircraft (registration C-FQYW, serial number 60-8265020), departed Cabo San Lucas International Airport (MMSL), Baja California Sur, Mexico, with 3 people on board, for a 2-day trip to Nanaimo Airport (CYCD), British Columbia (BC). As planned the aircraft stopped for an overnight rest at Chino Airport (KCNO), California, U.S.

At 1142,[1] on 10 December 2019, the aircraft departed KCNO on a visual flight rules (VFR) flight plan to Bishop Airport (KBIH), California, U.S., for a planned fuel stop. The aircraft departed KBIH at approximately 1425 on an instrument flight rules (IFR) flight plan to CYCD. On 10 December 2019, night[2] started at 1654.

At 1741, the Vancouver area control centre air traffic controller advised the pilot that an aerodrome special meteorological report (SPECI)[3] had been issued for CYCD at 1731. The SPECI reported visibility as

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1 All times are Pacific Standard Time (Coordinated Universal Time minus 8 hours).

2 The *Canadian Aviation Regulations* define "night" as "the time between the end of evening civil twilight and the beginning of morning civil twilight." (Source: Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, subsection 101(1)).

3 According to NAV CANADA's *Aviation Services Weather Guide For Aviation Users,* "SPECIs are special weather observations, issued at times other than on the hour, as the result of significant weather changes." (Source: NAV CANADA, *Aviation Services Weather Guide For Aviation Users* [May 2017], Aviation Weather Observations Products, p. 14).

2 ½ statute miles (SM) in light drizzle and mist, with an overcast ceiling of 400 feet above ground level (AGL). The pilot informed the controller that he would be conducting an instrument landing system (ILS)[4] approach for Runway 16.

At 1749, when the aircraft was approximately 32 nautical miles (NM) south of CYCD, the pilot contacted the controller to inquire about the weather conditions at Victoria International Airport (CYYJ), BC. The controller informed the pilot that a SPECI was issued for CYYJ at 1709 and it reported the visibility as 5 SM in mist, a broken ceiling at 600 feet AGL, and an overcast layer at 1200 feet AGL.

The controller provided the occurrence flight with pilot observations from another aircraft that had landed at CYCD approximately 15 minutes before. That crew had reported being able to see the Runway 16 approach lights at minimums, i.e., at 373 feet AGL.[5] Between 1753 and 1802, the controller provided vectors to the pilot in order to intercept the ILS localizer.

At 1803, the controller observed that the aircraft had not intercepted the localizer for Runway 16. The aircraft had continued to the southwest, past the localizer, at an altitude of 2100 feet above sea level (ASL) and a ground speed of 140 knots. The controller queried the pilot to confirm that he was still planning to intercept the ILS for Runway 16. The pilot confirmed that he would be intercepting the ILS as planned.

The aircraft made a heading correction and momentarily lined up with the localizer before beginning a turn to the west. At 1804:03, the pilot requested vectors from the controller and informed him that he "just had a fail." The controller responded with instructions to "turn left heading zero nine zero, tight left turn." The pilot asked the controller to repeat the heading. The controller responded with instructions to "…turn right heading three six zero." The pilot acknowledged the heading; however, the aircraft continued turning right beyond the assigned heading while climbing to 2500 feet ASL and slowing to a ground speed of 80 knots.

The aircraft then began to descend, picking up speed as it was losing altitude. At 1804:33, the aircraft descended to 1800 feet ASL and reached a ground speed of 160 knots.

At 1804:40, the pilot informed the air traffic controller that the aircraft had lost its attitude indicator.[6] At the same time, the aircraft was climbing into a 2nd right turn.

At 1804:44, the air traffic controller asked the pilot what he needed from him; the pilot replied he needed a heading. The controller provided the pilot with a heading of three six zero.

At 1804:47, the aircraft reached an altitude of 2700 feet ASL and a ground speed of 60 knots. The aircraft continued its right turn and began to lose altitude. The controller instructed the pilot to gain altitude if he was able to; however, the pilot did not acknowledge the instruction. The last encoded radar return for the aircraft was at 1805:26, when the aircraft was at 300 feet ASL and travelling at a ground speed of 120 knots (Figure 1).

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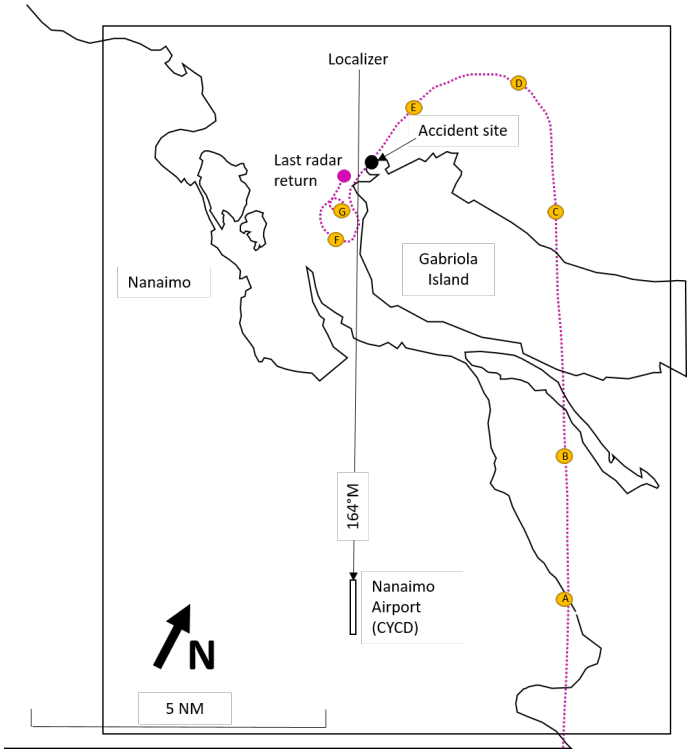
[4] « Instrument landing systems (ILS) are designed to provide aircraft with precision final approach guidance, offering a horizontal and vertical flight path to the runway. » (Source: NAV CANADA, Operational Initiatives: Instrument Landing System, at https://www.navcanada.ca/EN/products-and-services/Pages/on-board-operational-initiatives-ils.aspx [last accessed 20 July 2020]).

[5] The elevation of Nanaimo Airport (CYCD) is 92 feet ASL.

[6] An attitude indicator is a gyroscopic instrument that provides pitch and roll information relative to the horizon.

Figure 1. Flight path of occurrence aircraft based on radar data (Source: TSB)



Point	Time (PST*)	Ground speed (knots)	Radar altitude (feet ASL)
A	1758:44	180	5000
B	1759:43	210	4000
C	1801:14	210	3000
D	1801:58	220	2000
E	1802:41	190	1900
F	1804:03	80	2400
G	1804:47	60	2700
Last radar return	1805:26	120	300

*PST means “Pacific standard time”.

Control of the aircraft was lost. The aircraft collided with a power pole and trees in a wooded park area on Gabriola Island, BC, and then impacted the ground. The aircraft broke into pieces and caught fire. The 3 occupants on board received fatal injuries. As a result of being damaged in the accident, the emergency locator transmitter (Artex ME406, serial number 188-00293) did not activate.

Weather information

The investigation was unable to determine what aviation weather was reviewed by the pilot before the flight.

Aviation weather forecasts for CYCD available before the occurrence aircraft departed KBIH indicated light southeasterly surface winds, with visibility of 1 SM in light drizzle and mist, a broken ceiling at 400 feet AGL, and an overcast layer at 1000 feet AGL for the estimated time of arrival.

The aerodrome routine meteorological report for CYCD at 1800, i.e., approximately 6 minutes before the accident, indicated calm winds, visibility 2 SM in light drizzle and mist, and a ragged overcast ceiling at 400 feet AGL.

Aircraft information

The Piper Aerostar PA-60-602P is a pressurized twin-engine 6-seat aircraft certified for IFR flight. The occurrence aircraft was built in 1982 and imported to Canada in 2003. The aircraft was modified with 2 counter-rotating piston engines capable of producing 350 hp each and winglets. As a result of these modifications, the service ceiling was increased to 30 000 feet and the maximum allowable gross weight

to 6850 pounds. All of these modifications were carried out as per the appropriate supplemental type certificate.

The last entry in the occurrence aircraft's journey log was on 28 November 2019. It indicated that the aircraft had accumulated a total of 5736.2 hours. The investigation determined that the aircraft had since flown an additional 7 flights totalling a further 16.1 hours (not including the occurrence flight).

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was it required to by regulation.

Attitude indicator

The occurrence aircraft was equipped with a BendixKing KI 256 flight command indicator (FCI), which is a pressure-driven attitude indicator with position sensing and digital circuitry. The KI 256 FCI front display provides immediate visual aircraft pitch and roll attitude information to the pilot while its internal position sensing and digital circuitry generate a pitch and roll reference signal for use by the flight computer system (a BendixKing KFC 225), which includes the autopilot. When the KI 256 FCI stops working, there is no indication to alert the pilot of the failure. It may become sluggish or the bars displaying the flight commands may become unstable (jittery).

The KI 256 FCI was installed in the centre of the left instrument panel of the occurrence aircraft. During the occurrence, the pilot informed air traffic control that the FCI had failed. The aircraft was not equipped with a 2nd attitude indicator nor was it required to be by regulation.[7]

The investigation determined that the FCI on board the occurrence aircraft was last overhauled in December 2015. There is no recommended overhaul interval for the KI 256 FCI.

The FCI was retrieved from the aircraft wreckage and sent for examination to the TSB Engineering Laboratory in Ottawa, Ontario. Because the FCI had sustained severe structural damage as a result of the accident, the TSB Engineering Laboratory was unable to determine its serviceability.

Pneumatic system

The Piper Aerostar has a positive-pressure pneumatic system driven by 1 pneumatic pump on each engine. Air from each pneumatic pump is supplied to a common manifold with check valves so that if 1 pump fails, there is still pneumatic pressure available to the gyro-powered flight instruments, including the FCI. The aircraft deice boots and pressurized cabin door seals are inflated with pneumatic pressure and if a leak develops in the system, pumps could fail prematurely if they are running at high pressure.

A gyroscope pressure gauge is located in the upper right corner of the right instrument panel. The gauge has 2 indicators (1 for each pump) that show red when the pumps are inoperative. The gauge does not contain its own lighting source.

The pressure gauge of the occurrence aircraft was tested by the TSB Engineering Laboratory; however, all damage observed during examination was likely the result of the impact. Actual pressure at impact could not be determined.

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[7] Paragraph 605.18(c) of the *Canadian Aviation Regulations* requires that power-driven aircraft used for the purpose of IFR flights be equipped with "an attitude indicator."

The replacement interval for the pneumatic pumps set by the manufacturer[8] is 400 aircraft hours or 6 years, whichever comes first.

At the time of the accident, the left- and right-engine pneumatic pumps had respectively accumulated 415 aircraft hours (47 months) and 186 aircraft hours (29 months) of service, including the 3.75 hours of the occurrence flight.

The right-engine pneumatic pump was found damaged at the accident site and sent to the TSB Engineering Laboratory for examination. The TSB Engineering Laboratory concluded that had the pump drive assembly been intact pre-occurrence, it is likely that the pump would have been able to produce pressure.

Horizontal situation indicator

The occurrence aircraft was equipped with a BendixKing KI 825 electronic horizontal situation indicator (HSI) that was interfaced to the flight control system and GPS (global positioning system) Garmin GNS530W/430W. The HSI also supplies the autopilot system with heading information.

The investigation determined that the HSI had failed briefly during operation on 22 November 2019 and a 2nd time, 3 days later, on 26 November 2019. The KI 825 HSI is electrically driven and therefore is either on and working, or off and dark with no display. The aircraft owner was in contact with an aircraft maintenance organization located at Boundary Bay Airport (CZBB), BC, and an appointment to bring the occurrence aircraft in for troubleshooting of the 2 brief HSI malfunctions had been made for 11 December 2019, i.e., the day after the accident.

In total, 13 flights had been conducted after the 1st failure of the HSI. There were no journey log entries for defects with the HSI or evidence of maintenance completed. Regulations[9] require that defects that become apparent during flight operations be entered in the aircraft journey logbook, and advisory guidance in the regulatory standards[10] states that all equipment required for a particular flight or type of operation, such as the HSI in this case, be functioning correctly before flight.

The HSI was destroyed in the accident and the investigation was unable to determine if it was operational on impact. Similarly, it could not be determined if the HSI was supplying the autopilot with heading information, or if the autopilot was engaged during the approach.

Pilot information

The investigation could not determine who was flying the aircraft. Both occupants seated in the front of the aircraft held valid pilot licences.

The pilot in the front left seat, traditionally the pilot's seat, held a private pilot licence – aeroplane, with ratings to operate single-engine aircraft and seaplanes, and to conduct night and VFR over-the-top[11]

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[8] Parker Hannifin Corporation, Airborne Air & Fuel Products Service Letter 58A (23 March 2006), at https://www.parker.com/literature/Fluid%20Systems%20Division/AFD%20Static%20Files%20for%20Literature/SL-58A.pdf (last accessed 21 July 2020).

[9] Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, subsection 605.94(1) Journey Log Requirements.

[10] Ibid., Standard 625 - Aircraft Equipment and Maintenance Standard - Canadian Aviation Regulations, paragraph 625.10(i) Unserviceable Equipment - Aircraft without a Minimum Equipment List.

[11] A VFR over-the-top rating allows pilots to operate VFR while over cloud.

flights. He had a valid Category 1 medical certificate. He had accumulated over 320 hours total flight time, including 11.2 hours total night flight time. He did not have an instrument flight rules (IFR) rating, though he had received 28.7 hours under-the-hood training.[12] Records did not reveal any multi-engine aircraft flight time or actual IFR flights.

The pilot in the front right seat was the aircraft owner and was in possession of an airline transport pilot licence – aeroplane, a commercial pilot licence – helicopter, a pilot licence – glider, and a pilot permit – ultra-light aeroplane. He held a valid Category 1 medical certificate. He had accumulated over 13 000 hours total flight time. In April 2019, he had completed an instrument proficiency check[13] that included a recovery from an unusual attitude and a recovery from an unusual attitude using a partial instrument panel in accordance with Transport Canada's guidance.[14] He also had experience providing flying instruction in airplanes, helicopters, gliders, and ultra-light aircraft.

Recovering with partial instruments

Training for an instrument rating, and subsequent proficiency checks, expose pilots to partial panel scenarios where they are required to maintain or regain situational awareness following the failure of a primary instrument. However, if the autopilot disengages unexpectedly while the aircraft is in instrument meterological conditions and one or more instruments fail, this results in a very high workload for pilots. In this scenario, not only is the process of re-establishing situational awareness significantly more difficult without external visual cues, but it becomes even more difficult without sufficient internal cues.

Pilots who are experiencing high cognitive workload conditions will be vulnerable to perceptual bias (selectively focusing attention on specific cues at the sacrifice of the wider scenario) or narrowing of attention (reducing their ability to scan and process information) through stress, and will be dependent on the remaining cockpit displays, communication with other flight crew members, and their own perceptions of motion and orientation to be able to continue the flight safely.

Susceptibility to spatial disorientation

Spatial disorientation can be described as "the inability of a pilot to correctly interpret aircraft attitude, altitude or airspeed in relation to the Earth or other points of reference."[15]

In addition to being vulnerable to perceptual bias or narrowing of attention, pilots who are experiencing high cognitive workload conditions—having to unexpectedly re-establish situational awareness without reference to external visual cues and with insufficient internal cues—are at an increased risk of experiencing spatial disorientation if they rely too heavily on their perceptions of motion and orientation.

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[12] Under-the-hood training indicates "that the pilot is using a hood to restrict visibility outside the cockpit while simulating instrument flight." (Source: Transport Canada, Advisory Circular (AC) 100-001, *Glossary for Pilots and Air Traffic Personnel*, Issue 6 (26 September 2019), at https://www.tc.gc.ca/en/services/aviation/reference-centre/advisory-circulars/ac-100-001.html#s4_7 (last accessed on 26 June 2020).

[13] An instrument proficiency check is a recurring event to confirm retention of a level of practical knowledge and flight proficiency that meets the standards of performance required for the issuance of an instrument rating.

[14] Transport Canada, AC 401-004, *Conduct of Instrument Proficiency Checks*, Issue 4 (15 March 2019), at https://www.tc.gc.ca/en/services/aviation/reference-centre/advisory-circulars/ac-401-004.html (last accessed on 26 June 2020).

[15] SKYbrary, "Spatial Disorientation" at https://www.skybrary.aero/index.php/Spatial_Disorientation (last accessed 21 July 2020).

When pilots do not have reliable external or internal cues to alert them to the aircraft's orientation, they can become susceptible to vestibular illusions. These illusions can cause pilots to sense that the aircraft is level even though it is in a bank or pitched up or down. This illusion may continue unrecognized until the aircraft impacts terrain.

Safety messages

Aircraft owners must ensure that aircraft deficiencies are recorded and rectified before flight.

The lack of external visual cues, the loss of instruments, and the on-set of acute stress with perceptual bias or narrowing of attention are all factors that increase the risk of spatial disorientation. In such situations, pilots may become reliant on their perceptions of motion and orientation, which would make them susceptible to disorientation.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 15 July 2020. It was officially released on 27 July 2020.

ABOUT THIS INVESTIGATION REPORT

This report is the result of an investigation into a class 4 occurrence. For more information, see the Policy on Occurrence Classification at www.tsb.gc.ca

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