AVIATION INVESTIGATION REPORT
A01C0236

CONTROLLED FLIGHT INTO TERRAIN (CFIT)

PERIMETER AIRLINES (INLAND) LTD.
FAIRCHILD SA226TC C-GYPA
SHAMATTAWA, MANITOBA
11 OCTOBER 2001

Aviation Investigation Report

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Summary

Perimeter Airlines Flight PAG962, a Fairchild SA226TC (Metroliner), with two pilots and a flight nurse on board, departed Gods Lake Narrows, Manitoba, at approximately 2300 central daylight time, on a MEDEVAC flight to Shamattawa. Approaching Shamattawa, the crew began a descent to the 100 nautical mile minimum safe altitude of 2300 feet above sea level (asl) and, when clear of an overcast cloud layer at about 3000 feet asl, attempted a night, visual approach to Runway 01. The aircraft was too high and too fast on final approach and the crew elected to carry out a missed approach. Approximately 30 seconds after the power was increased, at 2333, the aircraft flew into trees slightly to the left of the runway centreline and about 2600 feet from the departure end of Runway 01. The aircraft was equipped with a cockpit voice recorder (CVR) that indicated the crew were in control of the aircraft; they did not express any concern prior to impact. The aircraft broke apart along a wreckage trail of about 850 feet. Only the cabin aft of the cockpit retained some structural integrity. The captain and first officer were fatally injured on impact. The flight nurse was seriously injured but was able to exit the wreckage of the cabin. A post-crash fire was confined to the wings which had separated from the cabin and cockpit wreckage.

Ce rapport est également disponible en français.

Other Factual Information

Perimeter Airlines Ltd. operates a fleet of Fairchild Metroliner aircraft under *Canadian Aviation Regulations* (CAR) 703 and 704, providing air taxi and commuter air services. These services extend into sparsely-settled areas and fly-in communities. The company had re-activated medical evacuation services (MEDEVAC) about six months before the accident flight and was licenced by the Province of Manitoba to provide these services. C-GYPA had been modified to accommodate patients and to allow the provision of medical care en route. C-GYPA had been based at Gods Lake Narrows, Manitoba, to optimize response times. The MEDEVAC crew, consisting of two pilots and one flight nurse, were rotated on a regular basis..

The occurrence aircraft was equipped with a solid-state Universal Avionics Systems Corporation CVR-30 cockpit voice recorder (CVR). The CVR was recovered and analyzed at the TSB Engineering Laboratory. All four channels were clear, and the recorded sounds were easily discernible. The CVR was of excellent quality from take-off at Gods Lake Narrows to the crash at Shamattawa.

C-GYPA was not equipped with a flight data recorder (FDR) nor was it required to be. The Metroliner had a maximum certificated take-off weight (MCTW) of 12 500 pounds.[1] At take-off, the aircraft was under the MCTW. The aircraft's centre of gravity was within limits throughout the flight.

On the day of the occurrence, the two pilots returned from a week's leave and had flown to Gods Lake Narrows on a company aircraft, arriving about 1100 central daylight time (CDT)[2] to relieve the outgoing MEDEVAC crew. During the day, the captain and first officer spent a leisurely afternoon fishing. After supper, the crew relaxed in the lounge area watching television until about 2200, when they were tasked with a MEDEVAC flight.

The captain had approximately 3100 hours flight time and held a valid airline transport pilot licence. His medical certificate, endorsed on 27 February 2001, indicated that glasses must be worn. His Group 1 instrument rating and captaincy had been renewed by a pilot proficiency check (PPC) completed on 28 May 2001. The captain had been employed by the company for about one and a half years and had completed an initial PPC as a Metroliner captain on 26 May 2000. Company records indicated that he had about 1100 hours on type and had completed controlled flight into terrain (CFIT) training in December 2000.

The first officer had approximately 1200 hours flight time and held a valid commercial pilot licence. The first officer had completed a PPC on 26 August 2001 renewing his Group 1 instrument rating and type rating. He had completed an initial PPC as a Metroliner first officer on 24 August 2000 and had been flying for the company for about 14 months. Company records indicated that he had about 900 hours on type and had completed CFIT training in December 2000.

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1 Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.

2 All times are CDT (Coordinated Universal Time [UTC] minus six hours).

The autopsy results indicate that both crew members were fatally injured on impact. The autopsy and toxicology test of the captain did not reveal any pre-existing condition or substance that could have affected the captain's performance. Injuries to the captain's hands and feet were consistent with the types of injuries that are sustained while at the controls of an aircraft during an accident. The autopsy of the first officer revealed two pre-existing medical conditions that could have affected his performance: severe stenosis of the left anterior descending coronary artery with dilated cardiomegaly (510 g) and thyroiditis. The toxicology test of the first officer was positive for the presence of cannabinoids (THC) in excess of 50 ng/ml. The cutoff levels may vary from laboratory to laboratory, but a general rule is for a specimen to be considered positive for THC there must be 50 ng/ml cannabinoids in the screening immunoassay.[3] There is no Transport Canada regulation regarding testing for drug use in commercial pilots.

The company has a company aviation safety officer (CASO), who was in position at the time of the accident. All company personnel are free to bring concerns to the CASO anonymously. The CASO has direct access to the company president on any safety matter.

Shamattawa is a small, isolated community located approximately 400 nautical miles (nm) northeast of Winnipeg. The community is served by a certified airport, operated by the Government of Manitoba. The field elevation is 289 feet above sea level (asl). The single, gravel Runway 01/19 is 4000 feet long with low-intensity runway lighting. Each end of the runway has green threshold and red edge lighting. All runway lighting can be operated by radio from an aircraft[4] and is activated for approximately 15 minutes by the pilot keying the microphone five times within five seconds. The timing cycle can be restarted at anytime.

On the evening of the occurrence, all runway lights were observed to be functioning. Neither runway at the airport was served by a ground-based, visual approach slope indicator (VASIS). A VASIS is a series of lights designed to provide visual indications of the desired approach slope to a runway. The runway is served by a privately operated, unmonitored, non-directional beacon (NDB). The NDB approach is for company use only and is not published in the *Canada Air Pilot* (see Appendix A). On the evening of the occurrence, the NDB was not turned on until the aircraft had crossed the runway threshold. The community is located to the south of the runway in the direction from which the aircraft approached. There were no ground lights beyond the end of this runway in the direction that the missed approach was conducted.

At the time of the occurrence, there was overcast cloud with no celestial light in the Shamattawa area. The airport manager reported to the crew that the surface winds were light and variable, and the altimeter setting was 29.89 inches. The crew did not use the new altimeter setting and left the altimeters set at 29.82 inches. The crew took this action to compensate for any errors that may have existed in the altimeter setting provided. The effect of using the lower altimeter setting would have been to fly the aircraft about 70 feet above the altitude that would have been flown with the higher setting.
The crew used a global positioning system (GPS) for the initial descent and became visual at about 3000 feet asl about 5 nm from the airfield. They flew a left hand visual approach and configured the aircraft for landing. At 3 nm, they were about 700 feet above the desired approach path. They completed the final landing check,

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[3] Dr. Vern Davis, *Guidelines for the Accident Investigator in the Interpretation of Positive THC (Cannabinoids) Results* – Prepared for the Transportation Safety Board.

[4] ARCAL - aircraft radio control of aerodrome lighting.

and the airspeed and altitude were still too high. Both pilots concurred that a missed approach was necessary, and the captain initiated it by calling for maximum power. The Shamattawa NDB came on the air just before the crew commenced the missed approach; the sound level of the NDB was high in the intercom system compared to the voices of the crew. The aircraft was seen over the threshold of the runway at about the height of the trees that were parallel to the runway along the airport boundary. During the missed approach, the aircraft's nose moved upwards initially, but the aircraft did not climb away, staying at the approximate height of the trees along the airport boundary.

As the first officer was setting the engine power, the captain called positive rate[5] and gear up. The first officer raised the landing gear, retracted the flaps, and set the engine torque for the missed approach. Approximately 20 seconds after starting the missed approach, and 7 seconds before impact, the captain indicated that he would climb to 1300 feet asl and go around left hand, and the sound of the Shamattawa NDB in the intercom system stopped. Two seconds later, the aircraft struck the trees. The first officer did not make the "400 feet" or "Obstacle Clearance Altitude" call.

In the investigation of a similar CFIT accident[6] involving a Metroliner 3 aircraft at Terrace, British Columbia, on 26 September 1989, the following explanation of two relevant flight illusions, somatogravic and somatogyral, was presented.

> Errors in the perception of attitude can occur when aircrew are exposed to force environments that differ significantly from those experienced during normal activity on the surface of the earth where the force of gravity is a stable reference and is regarded as the vertical. The acceleration of gravity is the same physical phenomenon as an imposed acceleration, and hence, in certain circumstances, one may not be easily distinguishable from the other.
> When the imposed acceleration is of short duration such as the bounce of a car or the motion of a swing, one can separate perceptually the imposed motion from that of gravity. When the imposed acceleration is sustained, however, such as the prolonged acceleration of an aircraft along its flight path, the human perceptual mechanism is unable to distinguish the imposed acceleration from that of gravity. The body senses the sum of these two accelerations, and this resultant sum becomes the reference acceleration which is regarded as the vertical. Illusions of attitude occur almost exclusively when there are no outside visual references to provide a true horizon.
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> In the absence of visual cues, the perception of motion and position is sensed primarily by the vestibular organs, and hence the term vestibular illusion is used to describe the circumstances where these organs do not correctly sense motion and/or position. Experiments have shown that there are large individual differences in the magnitude of such illusions and in the time required for the illusions to develop.

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[5] According to the company standard operating procedures (SOPs) for take-off, either pilot can call "positive rate". There is no such directive for the missed approach.

[6] TSB report number A89H0007.

> If one considers an aircraft flying straight and level and accelerating along the direction of flight because of an increase in power, for example, then the direction of the inertial force due to the acceleration is to the rear of the aircraft and, for the purposes of this discussion, can be assumed to be along the longitudinal axis of the aircraft. This inertial force combines with the force of gravity to produce a resultant which is inclined to the rear of the aircraft. If this resultant is then used by the pilot as the vertical reference, then the pilot will incorrectly sense that the aircraft is in a nose-up attitude. If the pilot then trims or eases forward on the control column to correct for this nose-up perception, the nose of the aircraft will drop and the airspeed will increase. This change in attitude will change the direction of the resultant force vector in such a manner as to maintain and perhaps magnify the illusory perception of a nose-up attitude.
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> Significant errors in perception can develop within the first few seconds of a change in the force environment. Experiments carried out in flight have shown that there is little lag in the onset of the illusion and that there is a relatively rapid increase in its magnitude during the initial six to eight seconds. This illusion is known as the somatogravic illusion, and it is particularly dangerous when it occurs on take-off or when overshooting, especially at night or in poor visibility. An aircraft deceleration will result in the opposite effect, that is, a perceived nose-down attitude.

The wings, ailerons and aileron trim tabs, flaps, horizontal stabilizer, elevators, vertical fin, and the rudder and rudder trim tab were located at the occurrence site. It was established that all flying surfaces and flight control surfaces were intact at the time of initial impact with the trees. More extensive examination of push-pull tubes, control cables, turnbuckles, and bell cranks did not reveal any pre-impact failures. The damage to the cockpit area was extensive and both the captain's and first officer's control wheel assemblies were broken from the tops of the vertical columns, which in turn had separated at the floor. All damage to these cockpit structures suggested post-impact damage. This in situ examination, and the CVR information, revealed no indication of any control system malfunction or failure prior to impact.

Both propellers were examined and disassembled in the regional wreckage examination facility. It was determined that neither propeller was feathered, and that both propellers were rotating under power at the time of impact. No reliable blade angle finding could be made, and no pre-impact power setting could be determined, from the propeller examination. There were no propeller discrepancies noted that could have precluded normal operation. All damage was consistent with impact damage.

The TSB Engineering Laboratory conducted a spectral analysis of the cockpit area microphone channel for the final 38 seconds of the flight. The analysis concluded that both engines were operating at 2000 rpm at high power up to the point of impact.

The aircraft was equipped with a stability augmentation system (SAS) to warn the pilot of an impending stall and, if necessary, to provide a positive nose-down pitching moment to prevent a stall. Although nothing was found to indicate that the crew had experienced an inadvertent stick pusher activation or that the warning horn activated, the SAS servo assembly was removed from the wreckage and examined at the TSB Engineering Laboratory. Examination of the servo indicated that the system was not activated at impact.

Cockpit instrumentation not destroyed on impact was examined by the TSB Engineering Laboratory. Examination revealed that the airspeed range on ground impact was likely 140 to 160 miles per hour; the rate of descent was about 2000 feet per minute; the altimeters were set to 29.82, and the altimeters were indicating between 0 to 1000 feet asl. None of the 96 lights in the 48-segment annunciator panel were illuminated. The landing gear warning lights were not illuminated, indicating that the landing gear was retracted.

The wreckage trail was documented using a handheld GPS unit. The wreckage trail started with tree strikes about 2600 feet on a bearing of 351 degrees true from the departure end of Runway 01. Trees at the start of the trail were about 45 feet high, and tree strikes indicated that the aircraft had a left bank angle of 20 to 30 degrees. The left wing struck the ground about 360 feet beyond the first tree strike, indicating a descent angle of about 7 degrees. The trail was approximately 850 feet long and oriented on a heading of 343 degrees true. The wings and engines separated from the fuselage of the aircraft and were destroyed by fire. The cockpit area was destroyed but not subjected to fire. The aft cabin area remained intact and came to rest, with the tail assembly, about 30 feet beyond the cockpit area.

The Fairchild SA226TC has a trimable horizontal stabilizer with elevators. The trim switches control an electrical linear actuator, comprising two parallel jack screws each with its own clutch, brake, electric motor, and electrically-separated actuating circuits. The CVR revealed that the trim was operated continuously between 15 and 5 seconds before impact. The direction of the trim operation was not determined; however, the trimming occurred as the landing gear and flaps were cycled up, which would likely require nose-down trim.

The electrical linear actuator was recovered from the wreckage. The actuator was disassembled at the manufacturing facility under the supervision of TSB Engineering staff. Both jackscrew motors were found in working order with both jack screws free to rotate up to crash-induced bends. The clutches also worked. One undamaged brake worked but the other could not be tested because of crash damage. It was concluded that the trim system was functional at the time of impact, and the position of the stabilizer indicates that there had not been a runaway trim situation.

The Perimeter Airlines standard operating procedures (SOPs) manual, dated 25 September 2001, specified the missed approach procedures to be followed by crews. Paragraph 1.5 of the SOPs details the standard calls to be made by the pilot flying (PF) and the pilot not flying (PNF) during a take-off and/or a missed approach. During the missed approach, the PNF is required to

call “positive rate” and the PF would then call “max power, gear and flap up”. The two-engine missed approach procedure is outlined in a diagram in Section 4.19 of the SOPs. The procedure outlined is as follows:

> Missed Approach
> Max Power
> Gear Up
> Flaps Up
> Rotate 8-10 Degrees Nose Up
> At 400 ft or Obstacle Clearance, accelerate to Single Engine Best Rate-of-Climb Speed.

No other procedures are specified for a missed approach.

The company also operates a flight training academy. In the academy’s multi-engine rating flight training manual dated 05 January 2001, the method of determining positive rate after take-off is specified. On page 11, the academy requires that positive rate be established by observing a positive rate on the altimeter and at least 500 feet per minute rate of climb on the vertical speed indicator.

Analysis

The aircraft struck terrain north of the airport while the crew was in controlled flight, executing a missed approach following a rejected visual approach to Runway 01 in night visual flight rules conditions. All indications are that the aircraft was functioning normally up to the point of impact. The analysis, therefore, will discuss the decisions and actions of the crew. Although reference is made to the term “missed approach”, the crew were conducting a visual approach and overshoot. After the rejected landing, the crew intended to fly a 1000-foot above ground level circuit for another landing attempt. However, given that there was no celestial light and no ground lights in the area of the missed approach, the aircraft would have had to be flown with reference to the flight instruments.

The medical review concluded that, while the autopsy findings with respect to the first officer’s cardiac conditions and thyroiditis were notable, there was no indication that they affected his performance before or during the accident. The review pointed out that cannabinoids are highly lipophilic, meaning that they are readily stored in fat. For this reason, it is possible for an individual to test positive for cannnabinoids for up to three months after drug use. The measurement of greater than 50 ng/ml is quantitative only in so far as it indicates that the concentration of cannabinoids was above the generally accepted positive level in occupational drug testing. It was impossible to determine the extent of cannabinoid use by the first officer or the timing of such use. Also, it was not possible to make a link between the first officer’s performance during the flight and the level of cannabinoid in his body. It is known that cannabinoid use can adversely affect human performance. The absence of drug testing for commercial pilots reduced the chance of detecting the presence of cannabis. Any company personnel who had concerns about drug use at the company were free to take such concerns to the company aviation safety officer.

The descent into Shamattawa, Manitoba, was started late, which led to the aircraft being high and fast on approach. Although the crew were aware that the aircraft was high and fast, they did not take effective action to resolve the problem and had to execute a missed approach. The use of the lower altimeter setting would have contributed to the aircraft being high on the approach.

The absence of ground-based VASIS made the determination of the approach angle more difficult for the crew. The presence of a VASIS would have enabled the crew to take earlier, more positive corrective action to avoid the missed approach. The ground-based observation that the aircraft did not climb, and the absence of a 400-foot call by the first officer, indicate that the required 8 to 10 degree pitch attitude was not set by the captain. Neither pilot revealed any awareness or concern that the aircraft was not in a climbing attitude. This lack of concern is an indication that the captain, at least, lost situational awareness after the missed approach was initiated, and that the first officer was either not monitoring the flight or he also lost situational awareness.

The loss of visual references as the aircraft accelerated along the runway and past the lights of the community were ideal for the onset of somatogravic illusion in the pilot flying. Even 7 seconds prior to impact, the captain believed that he was climbing to 1000 feet above ground level. The captain's performance was consistent with his being unable to distinguish the imposed acceleration as the aircraft speed increased from that of gravity and, although he probably thought the aircraft was climbing, it was not.

The first officer may also have been influenced by the somatogravic illusion. During the 30 seconds of the missed approach, his tasks were to react to the captain's commands and to monitor the instruments. Apparently the first officer did not observe anything remarkable or he would have alerted the captain that the aircraft was not climbing. It is possible that he was distracted by the sudden sound of the NDB identifiers just after the missed approach was initiated. The NDB receiver was turned off just prior to impact, and since the control head is on the first officer's side of the cockpit, it was likely he who turned the NDB off. Given the short duration of the overshoot and the tasks that the first officer was performing, it is probable that he had a false perception that the aircraft was climbing.

Even though the conditions were present for the crew to be affected by somatogravic illusions, these illusions could have been overcome by at least one of the crew. During the visual approach, the pilots were able to fly with visual reference to the surface. However, pilots are required to transition to instruments when entering, or about to enter, weather or environmental conditions where visual flight conditions do not prevail, as was the case when the overshoot was initiated. Had this transition been made, the fact that the aircraft was not climbing would have been evident.

The company SOPs for the missed approach was less stringent than those for the company's training school. There was no stated requirement to use instruments during a missed approach nor a requirement to identify two positive rates of climb. The use of these two techniques would be a stronger defence against the possibility of somatogravic illusion and loss of situational awareness.

The following TSB Engineering Laboratory reports were completed:

LP 097/01 — *Stabilizer Trim Electrical Linear Actuator*
LP 098/01 — *Instrument Examination*
LP 117/01 — *Stall Avoidance System*

These reports are available upon request from the Transportation Safety Board of Canada.

Findings as to Causes and Contributing Factors

1. The aircraft was flown into terrain during an overshoot because the required climb angle was not set and maintained to ensure a positive rate of climb.

2. During the go-around, conditions were present for somatogravic illusion, which most likely led to the captain losing situational awareness.

3. The first officer did not monitor the aircraft instruments during a critical stage of flight; it is possible that he was affected by somatogravic illusion and/or distracted by the non-directional beacon to the extent that he lost situational awareness.

Other Findings

1. The absence of approach aids likely decreased the crew's ability to fly an approach from which a landing could be executed safely.

2. The company standard operating procedures (SOPs) did not define how positive rate is to be determined.

Safety Action

Following the accident, the company made changes to aircraft equipment for medical evacuation (MEDEVAC) flights, revised the standard operating procedures (SOPs), and increased crew training. The company's MEDEVAC aircraft were equipped with an integrated hazard awareness system. This system provides voice descent and terrain warnings in critical flight situations such as missed approaches. Section 1.15 of the SOPs was amended to include a "three positive rates of climb" call to be made by the pilot flying in response to the "positive rate" call made by the pilot not flying. A new Section 2.23 was added to specify missed approach procedures in detail. Crew training has increased the emphasis on missed approaches and the similarities between northern night flying and instrument flight. The company has also introduced crew evaluations in a generic simulator during semi-annual recurrent training.

The Northern Airports Section of the Manitoba Transportation and Government Services Division, in cooperation with Transport Canada (TC) is in the process of providing precision approach path indicators (PAPI) at Manitoba's 22 northern airports. Installation is prioritized based on traffic volume. Shamattawa is expected to be included in the next four applications to

TC's Airport Capital Assistance Program. The Northern Airports Section has also replaced the Shamattawa non directional beacon (NDB) which did not operate during the approach by the occurrence aircraft.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 15 January 2003.

Visit the Transportation Safety Board's Web site (www.tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A - Shamattawa Approach Diagram