Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION OCCURRENCE REPORT

CONTROLLED FLIGHT INTO TERRAIN

AIRCO AIRCRAFT CHARTERS
PIPER PA-31-350 CHIEFTAIN C-FZBW
RAINBOW LAKE, ALBERTA
15 JANUARY 1998

REPORT NUMBER A98W0009

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Summary

The Airco Aircraft Charters Piper PA-31-350 Chieftain, serial number 31-8152096, had been chartered by Northern Sky Aviation to complete a daily passenger flight from the Edmonton City Centre Airport to High Level, Rainbow Lake, Edmonton, and Calgary, Alberta. The flight from Edmonton to High Level and Rainbow Lake was uneventful. Following a routine landing and turn around, the aircraft departed Rainbow Lake in darkness, at 1935 mountain standard time (MST)[1], on an instrument flight rules (IFR) flight to Edmonton. Shortly after take-off from runway 27, the aircraft collided with trees and terrain approximately 3 000 feet west of the departure end of the runway. The nine occupants sustained minor injuries and the aircraft was substantially damaged. Immediately following the evacuation of the aircraft, a Rainbow Lake passenger initiated the local emergency response by cell phone. Volunteer ground rescue personnel organized a snowmobile search, and a helicopter was dispatched from the airport to conduct an aerial search. The ground search was hampered by darkness, dense forest, cold temperatures, and deep snow. The helicopter pilot located the aircraft wreckage on his first pass over the departure corridor and, following his immediate return to the airport, he lead the ground rescuers to the accident site. Rescuers reached the accident site approximately one and one-half hours after the occurrence and assisted all of the survivors to the Rainbow Lake nursing station.

Ce rapport est également disponible en français.

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[1] All times are MST (Coordinated Universal Time minus seven hours) unless otherwise noted.

Other Factual Information

Aviation routine weather reports (METAR) are not available for Rainbow Lake. The pilot and passengers reported that the sky was clear with unrestricted visibility and light winds. The temperature was approximately minus 25 degrees Celsius. The ambient lighting conditions were described as dark, with no moon, and little illumination from the night sky. There are no ground or community lights to the west of the airport.

Northern Sky Aviation operated a domestic air service public charter flight six days a week between Edmonton, High Level, Rainbow Lake and Calgary with a Piper PA-31 Chieftain or a Beech King Air 200 aircraft. The flights departed on an as-needed basis from the different locations, and the type of aircraft that was assigned to the flight depended on the number of passengers that had reserved seats. The Chieftain was normally used when seven or fewer passengers had reserved seats on any leg of the flight. The Northern Sky Chieftain was not available on the day of the occurrence because of unscheduled maintenance. A maximum of seven passengers had reserved seats that day and accordingly, an Airco Aircraft Charters Piper PA-31-350 Chieftain was chartered for the flight. Airco had flown the route for Northern Sky several times in the past; however, the pilot that was assigned to the flight had not previously flown a Northern Sky charter.

The pilot had been employed by Airco as a charter pilot for approximately six months and was certified and qualified for the flight in accordance with existing regulations. He held a valid air transport pilot licence (ATPL) and had accumulated approximately 3 700 hours of flight time, including 93 hours on Piper PA-31 aircraft and 590 hours at night. He had commenced his flight training in Norway and obtained his private licence prior to immigrating to Canada in 1990. He had worked as a flight instructor and charter pilot at an Edmonton flying school from 1992 to 1997 and had taught ab initio, night, instrument, and multi-engine flying. He had been involved in two operationally related aircraft accidents during his instructing career. The majority of his charter flight experience had been as a single-pilot, and he reported that he preferred to fly under visual flight rules (VFR) when possible to reduce fuel costs. He had displayed weak IFR skills on several instrument check rides in the past. He had received instrument procedures simulator training while obtaining his instrument rating in 1991 and had taught instrument procedures as a simulator instructor. He had never received formal two-crew flight training, recurrent ground, or simulator training that emphasized controlled flight into terrain prevention strategies. Based on medical records and a post-accident medical examination, there was no evidence to indicate that the pilot's performance was degraded by physiological factors. He had been awake for 13.5 hours and on duty for 12 hours prior to the occurrence.

Northern Sky Aviation routinely assigned two pilots to the daily flights to comply with the requests of a number of regular passengers and to inspire customer confidence. In accordance with that policy, a Northern Sky Aviation co-pilot accompanied the flight as a customer service representative. He assisted with the passenger and baggage loading at each station, and he performed the passenger briefing before each departure. He held a valid commercial pilot licence with an instrument rating and had approximately 632 hours of total flight experience, including 168 hours at night. He had approximately 277 hours of flight time in the right seat of Piper PA-31 aircraft; however, he did not hold a pilot proficiency check (PPC) for the type. He had frequently departed Rainbow Lake at night on Northern Sky flights. The Airco captain

preferred to operate the aircraft as a single pilot, and the co-pilot was therefore not assigned any formal cockpit duties on this flight, other than to operate the flaps when requested. The co-pilot had been awake for eight and one-half hours, and on duty for eight hours prior to the accident.

Records show that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. There were no reported mechanical abnormalities with the aircraft throughout the flight to High Level and Rainbow Lake. The aircraft's engines were examined following the occurrence and no evidence of a malfunction was found. The elevator flight control system was determined to be continuous, and the elevator trim was found in the appropriate take-off position. The aircraft was fitted with a *Boundary Layer Research, Inc. Super Chieftain I Modification (STC SA00192SE)* that increased the maximum permissible take-off weight from 7 000 pounds to 7 368 pounds. The modification consisted of four engine nacelle strakes and 88 vortex generators affixed to the wings and vertical tail. The aircraft was not fitted with a ground proximity warning system (GPWS), and there was no regulatory requirement for GPWS to be installed. The aircraft was considered to be the poorest performer of the three Airco Chieftains.

Runway 27 at the Rainbow Lake Airport is 4 500 feet long[2], and is surfaced with asphalt. The airport lighting consists of low intensity runway edge lights, with green threshold and red end lights. There is no approach lighting. Runway 27 slopes uphill, and departures are accomplished into rising terrain. A survey determined that the threshold of runway 27 is 1 712 feet above sea level (asl), and that the departure threshold is 1 756 feet asl. The aircraft came to rest on level ground, at 1 784 feet asl. The deciduous and coniferous trees in the vicinity of the accident site were estimated to be 30 feet tall. A Transport Canada airport inspection completed on 07 April 1998 identified that trees and brush on the approach path to runway 09 violated the approach slope standard of 2.5% (1:40) and were required to be removed or topped. The amount by which the tree and brush height exceeded the approach slope standard was not determined.

A Northern Sky information brochure stated that each passenger was permitted to transport two pieces of baggage, with a maximum combined weight of 50 pounds. When the passenger, baggage, and fuel load resulted in a load that exceeded the gross weight of the Chieftain on any leg of the flight, it was the Northern Sky policy to remove the second pilot from the flight before reducing the number of passengers. Neither Airco Aircraft Charters nor the Airco pilot had been advised of this policy.

The pilot had been provided with a Northern Sky passenger manifest and had completed an Airco Charters computer-generated flight plan and gross weight calculation, with the assistance of the Airco operations manager, prior to leaving Edmonton. There was no evidence that centre of gravity (C of G) calculations had been performed. The flight plan indicated that the entire flight would be VFR, and that there would be a fuel stop in Peace River on the return leg. When the aircraft arrived in High Level the pilot received a message to call the Airco dispatcher. Upon calling the dispatcher, the pilot was informed that a Northern Sky representative had advised Airco that the flights did not normally stop in Peace River for fuel, and that Northern Sky preferred that the aircraft not stop in order that the flight remain on schedule. The Airco pilot consulted with the Northern Sky co-pilot and was advised that one male passenger had been replaced with a female passenger, that most of the passengers would be travelling light, and that several of them weighed less than the standard passenger weight. The pilot amended the flight

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[2] Units are consistent with official manuals, documents, and instructions used by or issued to the crew.

plan and added sufficient fuel to complete a VFR flight to Rainbow Lake and an IFR flight from Rainbow Lake to Edmonton. A copy of the original company flight plan, found on board the aircraft, indicated that the pilot had originally planned to leave Rainbow Lake with 504 pounds of fuel. Calculations completed after the accident indicated that approximately 850 pounds of fuel were on the aircraft at the time of departure from Rainbow Lake. Weight and balance calculations, using fuel weights at minus 20 degrees Celsius, estimated baggage weights and standard passenger weights of 188 pounds for each of the six males and 141 pounds for each of the three females on board, indicated that the aircraft was at approximately 7 473 pounds at take-off from Rainbow Lake, and that the C of G was near the aft limit. Calculations, using passenger self-reported weights, indicated that seven of the nine passengers exceeded the standard passenger weight, that the aircraft was approximately 7 683 pounds or about 315 pounds above the approved gross weight at take-off, and that the C of G was about 0.35 inches aft of the aft limit.

The aircraft initially struck the top of a tree approximately 2 700 feet west of the departure end of the runway. The aircraft remained airborne for approximately 300 feet before striking several more trees and descending to the ground. Wreckage trail examination determined that the aircraft was wings level in an approximate three-degree descent when it struck the trees. The main wreckage trail was approximately 615 feet long and consisted of a slash through a dense stand of poplar and aspen trees.

The aircraft came to rest upright, with both wings detached outboard of the engine nacelles due to tree strikes. The cockpit and cabin sections remained intact, and the occupant survival space was not compromised. All occupants reported smelling fuel prior to evacuating the aircraft. A male passenger seated in the aft-facing right front cabin seat opened the cabin emergency exit without difficulty, and six of the occupants evacuated through the emergency exit. The pilot was unable to open the left cockpit crew door due to distortion of the door frame. He broke the window in the crew door and exited through the window opening. A male passenger seated next to the main cabin entrance door was unable to locate and operate the latches for the lower half of the door. He forced open the top half of the door, crawled through the opening, and assisted one female passenger out of the same opening. Examination indicated that the wings-level impact attitude, the shallow impact angle, the small tree size, and the presence of approximately two feet of snow on the ground had contributed to maintaining the deceleration forces within the limits of human tolerance during the crash and had, thereby, enhanced occupant survival. The peril of a fuel-fed post-crash fire was reduced because the battery had been torn from the aircraft approximately half way down the wreckage trail, thereby eliminating the risk of electrical arcing.

The aircraft was reportedly equipped with a survival kit, as required by regulation, that was normally carried in the forward half of the right nacelle baggage compartment. However, the kit was not made available to the passengers. In the absence of a survival kit, the passengers managed, with great difficulty, to kindle only a small fire for warmth. Investigators did not locate the kit in the aircraft, and, since it was not used or found, it is presumed that it was not on the aircraft for this flight.

Aircraft using Rainbow Lake typically land on runway 27 and depart runway 09 if the wind conditions permit. A large number of residential and industrial lights are visible to the east of the airport during night departures. On arrival at Rainbow Lake, the pilot had been advised by the

Northern Sky co-pilot of a minor frost heave in the runway near the threshold of runway 09. In order to avoid the risk of damaging the nosewheel during the take-off run, the pilot had elected to depart on runway 27.

The pilot reported that he had selected 10 degrees of flap for the take-off, and that he had rotated the aircraft at 85 knots indicated airspeed (IAS). He believed that the aircraft became airborne at 90 knots, approximately half way down the runway, and that he had established and maintained a positive rate of climb. He reported that he was waiting for the aircraft to accelerate to the "blue line" speed (single engine best rate of climb) of 107 knots IAS, prior to lifting the flaps, when the aircraft struck the trees. He could not recall the altimeter and vertical speed indicator (VSI) indications during the seconds prior to impact. Wreckage examination determined that the landing gear and the flaps were in the UP position at impact.

The *Piper Chieftain, Pilot's Operating Handbook, Section 4*, describes NORMAL and SHORT FIELD take-off procedures:

> At 85 KIAS, rotate to a 10-degree pitch attitude and allow the aircraft to fly off. Maintain a pitch attitude which will result in acceleration of the aircraft to 95 KIAS at 50 feet. Before airspeed reaches 128 KIAS, retract the landing gear. Continue acceleration to the desired climb airspeed.

The take-off distance charts in the *Boundary Layer Research, Inc. Piper PA-31-350 Flight Manual Supplement* also identify that the 50-foot obstacle clearance barrier speed is 95 KIAS.

The accepted initial climb procedure after take-off is to establish a positive rate of climb with reference to the attitude indicator, maintain a climb indication on the altimeter and VSI, and climb at the appropriate best rate, or the best angle of climb IAS until clear of obstacles.

The pilot lost sight of the runway lights soon after lift-off and was confronted with dark, featureless terrain outside the cockpit. Darkness and the absence of external visual clues such as ground lights may induce a false perception of altitude and attitude. Under acceleration, the combination of gravity and the inertial forces produce a resultant force at an angle aft of the true vertical. This force acting on the vestibular system of the human inner ear can, in conditions of reduced or no visibility, give a false pitch up sensation. While the aircraft may be flying straight and level, or climbing slightly, the pilot may have a sensation of climbing at a much steeper angle than he actually is. Without visual input to override the false sensation, the pilot will usually pitch the aircraft's nose down to correct the perceived steep climb and inadvertently descend. This form of spatial disorientation is known as the "false climb" illusion or the somatogravic illusion. The extent, if any, to which somatogravic illusion contributed to the accident was not determined.

Several passengers reported that following an apparent normal ground roll and lift-off, the aircraft did not seem to be gaining altitude. It then pitched slightly nose-down immediately before striking trees. The Northern Sky co-pilot reported that the VSI was indicating 500 feet per minute down, and that the pitch attitude was one to two degrees nose-low when the aircraft struck the trees.

Analysis

There is no evidence that weather or a mechanical discrepancy contributed to the accident. The analysis will therefore focus on the pilot's applied IFR/night take-off technique, the role and influence of the quasi co-pilot, the communications between Airco Aircraft Charters and Northern Sky Aviation, the Airco dispatcher's request to change the flight plan, and the effect of the overweight condition of the aircraft on the departure. Individually these factors would likely not have been significant enough to cause an accident. When combined with dark ambient conditions and an uphill take-off toward rising terrain, these factors collectively established a window of opportunity for an accident to occur.

The pilot's night departure technique is considered to be the active failure in this accident. Night departures in dark conditions require full use of the aircraft flight instruments, and it is essential that the pilot achieve and maintain a positive rate of climb at a safe climb speed after lift off. In the absence of outside visual cues, the pilot must rely on the aircraft instruments to maintain airspeed and attitude and to overcome any false sensations of a climb. The pilot was either relying on outside visual cues during the initial climb and/or using only a partial instrument panel scan while being influenced by the false-climb illusion. Pilots can overcome false sensations by flying the aircraft with reference to the altimeter, VSI, attitude indicator, and airspeed indicator, which, in this case, would likely have allowed the pilot to detect that the aircraft was not established in a climb. The appropriate technique would have been to climb at the aircraft's best rate or best angle of climb speed until above all obstacles rather than become preoccupied with reaching blue line. The pilot may have intended to reach the blue line speed of 107 KIAS soon after take-off because he was aware that the aircraft was at or above the approved take-off weight, and he did not want to climb at a minimum climb airspeed.

The role of the Northern Sky Aviation company representative/quasi co-pilot is somewhat ambiguous, and his presence does not appear to have contributed significantly to the safety of the flight. Because he was not familiar to the captain and because he was not delegated flight crew responsibilities, his participation during the flight created a situation of crew resource mismanagement. The co-pilot's remarks regarding the weight and flight plan changes at High Level appear to have encouraged the captain to cancel the planned fuel stop in Peace River. In discussing the proposed changes the co-pilot did not advise the captain that if weight was a concern he could remain in Rainbow Lake and thereby reduce the take-off weight by approximately 170 pounds. The co-pilot's apparent well-intentioned advice on the frost heave near the threshold of runway 09 influenced the captain's decision to take-off on runway 27, which was uphill toward rising terrain and with no lights visible after departure. The co-pilot's attention to the flight instruments and aircraft climb profile during the initial climb phase of flight was such that he did not have time to intervene with the appropriate actions to prevent the aircraft from striking the trees.

The aircraft had been modified to permit take-off at a weight of 368 pounds higher than that approved by the original type certificate, without an increase in engine power. It is estimated that the actual weight of the aircraft at take-off was approximately 315 pounds above the prescribed increased gross weight, and that the C of G was at or beyond the rear limit. This would have increased the take-off distance and reduced the climb performance of the aircraft. The extent to which the aircraft performance was degraded was not determined. The Airco

dispatcher's telephone request to the captain in High Level to add sufficient fuel in order for the flight to not stop at Peace River contributed to the aircraft being overweight on the departure from Rainbow Lake.

Communication between Northern Sky and Airco Aircraft Charters with regard to the duties of the co-pilot and the weight of the aircraft at departure from Rainbow Lake were inadequate. Both companies were familiar with Piper PA-31-350 capabilities, and the weight and balance calculations performed prior to the aircraft leaving Edmonton indicated that the trip would have to be accomplished VFR, with a fuel stop at Peace River, to accommodate the passenger load. Critical information, such as the option of dropping the Northern Sky co-pilot in the event of an overweight aircraft condition, was never provided to Airco. The Airco pilot, who was the final decision-maker, was put in the position of having to balance the conflicting objectives of operating the aircraft within the prescribed weight limits and satisfying the customer demands. He was relatively inexperienced on Piper PA-31-350 aircraft, having flown less than 100 hours on the type, and because he had not previously flown a Northern Sky trip he was unfamiliar with the routine of the Northern Sky daily flights. He was aware that Northern Sky often chartered an Airco aircraft for the daily flight, and may therefore have felt peer pressure to fly the trip as he perceived other pilots had in the past.

Findings

1. The pilot was qualified for the flight, and there was no evidence that his performance was degraded by physiological factors.

2. The pilot's take-off technique was not appropriate for a night departure in that he concentrated on reaching *blue line* speed rather than maintaining a positive rate of climb after take-off.

3. The role of the Northern Sky company representative/co-pilot was ambiguous, and his presence does not appear to have contributed to the safety of the flight.

4. To the extent that the aircraft was examined, there was no evidence that an airframe, engine, or system failure contributed to the occurrence.

5. Airco Aircraft Charters had not been advised by Northern Sky Aviation of the option to drop the Northern Sky company representative/co-pilot in the event that the aircraft was overweight.

6. Using the reported passenger and baggage weights, it is estimated that the aircraft exceeded the maximum take-off weight by approximately 315 pounds and the centre of gravity was beyond the aft limit.

7. An airport inspection completed on 07 April 1998 determined that trees and brush on the approach path to runway 09 violated the approach slope of 2.5% (1:40).

8. The availability and use of a cell phone greatly expedited the rescue.

9. There was no survival gear available for the occupants.

Causes and Contributing Factors

The aircraft was inadvertently flown into trees and the ground, in controlled flight and dark ambient conditions, during a night departure because a positive rate of climb was not maintained after take off. Factors contributing to the accident were the pilot's concentrating on blue line speed rather than maintaining a positive rate of climb, the dark ambient conditions, a departure profile into rising terrain, an overweight aircraft, and crew resource mismanagement.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 08 January 1999.