Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION OCCURRENCE REPORT

COLLISION WITH FROZEN LAKE

EAGLE AIR SERVICES
PIPER PA-31-325 NAVAJO C-GOLM
WOLLASTON LAKE, SASKATCHEWAN 1 nm NE
25 NOVEMBER 1995

REPORT NUMBER A95C0250

Canada

MANDATE OF THE TSB

The *Canadian Transportation Accident Investigation and Safety Board Act* provides the legal framework governing the TSB's activities.

The TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability.

INDEPENDENCE

To encourage public confidence in transportation accident investigation, the investigating agency must be, and be seen to be, objective, independent and free from any conflicts of interest. The key feature of the TSB is its independence. It reports to Parliament through the President of the Queen`s Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations. Its continuing independence rests on its competence, openness, and integrity, together with the fairness of its processes.

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

Aviation Occurrence Report

Collision with Frozen Lake

Eagle Air Services
Piper PA-31-325 Navajo C-GOLM
Wollaston Lake, Saskatchewan 1 nm NE
25 November 1995

Report Number A95C0250

Synopsis

The medical evacuation (MEDEVAC) flight departed Wollaston Lake, Saskatchewan, at 2325 central standard time en route to La Ronge. After take-off, the aircraft turned about 70 degrees to the left, descended, and struck the frozen surface of Wollaston Lake. The pilot and the patient suffered serious injuries; the other two occupants suffered minor injuries. The aircraft was destroyed.

The Board determined that, after take-off, the left propeller was likely on its start locks, which, as the airspeed increased, allowed the propeller to overspeed. The pilot was unable to resolve the situation in time to prevent the aircraft from striking the surface of Wollaston Lake. Contributing to the severity of the patient's injuries were the inadequate restraint provided by the stretcher and its restraining strap, the lack of standards regarding stretchers used in aircraft, and the lack of standards as to the operation of MEDEVAC flights.

Ce rapport est également disponible en français.

Table of Contents

1.0 Factual Information

1.1 History of the Flight

The Eagle Air Services Piper PA-31-325 Navajo, C-GOLM, departed runway 34 at Wollaston Lake, Saskatchewan, at 2325 central standard time (CST)[1], on a medical evacuation (MEDEVAC)[2] flight to La Ronge. The flight was arranged by the Wollaston nursing station to transport a patient to a hospital in La Ronge. The patient was accompanied on the flight by her mother and a nurse from the nursing station.

The aircraft was observed to climb at an unusually shallow angle after take-off, and, when efforts by company personnel to reach the pilot by radio were unsuccessful, a ground search was commenced. The aircraft was found about five minutes after the accident, located on the ice- and snow-covered surface of Wollaston Lake, about 0.75 nautical miles (nm) from the departure end of the runway, and about 1.3 nm from the point of commencement of the take-off roll[3].

The pilot and the patient suffered serious injuries. The other two occupants sustained minor injuries. The accident occurred during the hours of darkness at latitude 58˚6.98'N, longitude 103˚10.79'W, at an elevation of 1,300 feet above sea level (asl). The temperature was about -25˚C.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	1	1	-	2
Minor/None	-	2	-	2
Total	1	3	-	4

1 All times are central standard time (Coordinated Universal Time [UTC] minus six hours) unless otherwise stated.

2 See Glossary at Appendix C for all abbreviations and acronyms.

3 See flight path diagram in Appendix A.

1.3 Damage to Aircraft

The aircraft was destroyed by the impact with the snow and ice, but the main cabin section maintained its structural integrity.

1.4 Other Damage

There was no other collateral damage.

1.5 Personnel Information

	Pilot
Age	27
Pilot Licence	ATPL
Medical Expiry Date	01/09/96
Total Flying Hours	4,920
Hours on Type	450
Hours Last 90 Days	181
Hours on Type Last 90 Days	178
Hours on Duty Prior to Occurrence	2
Hours Off Duty Prior to Work Period	22

1.6 *Aircraft Information*

Manufacturer	Piper Aircraft Corporation
Type and Model	PA-31-325
Year of Manufacture	1977
Serial Number	317712050
Certificate of Airworthiness (Flight Permit)	Issued 03/11/92
Total Airframe Time	7,056.8 hours
Engine Type (number of)	Left - Lycoming TIO-540 F2BD (1) Right - Lycoming LTIO-540 F2BD (1)
Propeller Type (number of)	Left - Hartzell HC-E3YR-2ATF (1) Right - Hartzell HC-E3YR-2ALTF (1)
Maximum Allowable Take-off Weight	6,500 pounds
Recommended Fuel Type	100 low lead
Fuel Type Used	100 low lead

The aircraft's maintenance records indicate that the aircraft was certified and maintained in accordance with existing regulations and approved procedures.

1.7 *Meteorological Information*

There is no Atmospheric Environment Service (AES) weather reporting station at Wollaston Lake. The nearest such station is at Lynn Lake, Manitoba, 103 nm southeast of Wollaston Lake. The 2300 weather report for Lynn Lake indicated high thin scattered cloud, visibility 15 miles, temperature -22˚C, and winds 300˚ at nine knots. Witnesses indicate that the weather at Wollaston Lake at the time of the accident was sky clear, visibility unrestricted, temperature about -25˚C, and winds northwest at about 10 knots.

1.8 Witness Reports

The aircraft was stored outdoors for about 23 hours before the flight. Between flights, an automotive-type electric heater was placed in the cabin. The heater was removed by the pilot when he arrived at the airport, about 20 minutes before the time of departure. After completing his pre-flight inspection, the pilot started and completed the aircraft run-up checks; he noted no abnormalities in the engines or propellers. He shut down the aircraft to refuel, then restarted the engines to position the aircraft in front of the operator's office in preparation for passenger loading. No heat was supplied to the aircraft's cabin from the time the interior heater was removed until the pilot selected the aircraft's combustion heaters on after take-off. There was no evidence of a fuel leak from any part of the aircraft before its departure. The pilot reported that, as a matter of personal preference, he set the aircraft's elevator trim so that the control column required a slight amount of back pressure to maintain level flight.

The pilot reported that the aircraft's handling and performance was normal during the take-off roll and that he switched on the two combustion heaters immediately after lift-off. Immediately after switching on the heaters, the pilot perceived that the aircraft's engines were no longer running in synchronization, and he believed that there was an engine problem and a possible loss of engine power. There was insufficient yaw effect to indicate which engine was affected, or to indicate the nature of the problem. The pilot reportedly confirmed by reference to the aircraft's instruments that the aircraft was maintaining the runway heading of 340˚, a pitch attitude of 9˚ nose-up, and an airspeed of 115 knots. He then confirmed that the engine and propeller controls were fully forward, re-checked the aircraft attitude, and then felt the aircraft's impact with the surface of Wollaston Lake. The pilot estimated that the aircraft was airborne for about four seconds.

Witnesses on the ground observed that the aircraft lifted off the runway after a ground run somewhat longer than previous ground runs of that aircraft. No abnormal sounds were noted during the ground roll. After lift-off, the aircraft's angle of climb was observed to be shallower than normal. The aircraft reportedly attained an altitude of about 100 feet above ground level (agl), turned to the left, and disappeared from the view of observers.

One of the passengers in the aircraft reported that, just before the impact with the lake, sparks, an arcing sound, and an electrical smell came from the cockpit area in front of the pilot.

1.9 Wreckage and Impact Information

The wreckage trail was about 450 feet long. The impact marks indicate that the aircraft struck the lake surface on a heading of about 270˚, in a left bank, and slightly nose down. The aircraft came to rest in an inverted position.

The left wing, complete with engine, was found in front of the main wreckage and had been completely severed from the fuselage. The main spar of this wing broke at the fuselage, and both forward and rear wing-to-fuselage attachment points failed in overload. The wing was also severed at the mid-point between the engine and the wing tip, with only the aileron cable connecting the two sections. Damage to the left nacelle indicated that the engine assembly had been pushed upward and rearward at impact.

The rear attachment point of the right wing had also failed in overload, and the outer portion of this wing was bent downward approximately 20 degrees, thereby rupturing the fuel tanks.
Both propellers had become detached from their respective engines; however, the left propeller had sustained more severe damage. In addition to having more severely bent and twisted blades, the left propeller broke apart in the spider area, thereby allowing one blade to become completely detached from the hub.

The nose cone, radome, and main battery were torn from the forward fuselage as the nose structure was forced upward and to the right, thereby crushing the cockpit area, predominantly on the right side. All occupied seats remained in their respective seat rails. Several electrical panels and buses were broken and detached from their mounts. Electrical sparks and arcing sounds and smells may emanate from electrical equipment if it is damaged while under electrical load.

The nose baggage door was found about 150 feet from the point of initial impact, and along the centre line of the wreckage trail. The overall damage patterns, the latch status, and the position of the door along the wreckage trail indicate that the door was closed and locked at impact.

At impact, the aircraft was configured with the gear up, flaps up, and all throttle, mixture, and propeller controls fully forward. The fuel selectors were found in the main tank positions while the fuel shut-offs were in the open position.

All flight control surfaces were accounted for and control continuity was established. A detailed examination of the airframe revealed no evidence of pre-impact structural failure.

1.10 Fire

After the aircraft struck the ice, a small fuel-fed fire started in the turbocharger area of the right engine. The fire was extinguished by persons from the community who arrived at the scene after the occurrence.

Both forward and rear combustion heaters were examined and no evidence of fire or pre-impact failure was found.

1.11 Tests and Examination

The engines were removed from the accident site and transported to the TSB regional wreckage examination facility in Winnipeg, Manitoba. During the preparation of the left engine for a test run, the engine-driven fuel pump was found to have a significant fuel leak at the rear cover of the pump body. This leak occurred under gravity fuel pressure before the engine was run, and was attributed to a hardened O-ring and a slight warping of the cover plate. The extent of the fuel leak and the evidence found at the accident site indicates that the unserviceability of the fuel pump occurred after the accident. The engine was test run and was found to operate within normal parameters with the exception of a slightly rich fuel mixture.

The right engine was not test run, because of the damage it had sustained. The engine was torn down, and all damage found was attributable to overload, impact forces, or heat from the post-crash fire. No pre-existing mechanical faults were revealed which would have contributed to a loss in engine power.

The propeller governors were tested, disassembled, and inspected, and both units were found to be functional and operating within accepted parameters.

Both propellers were sent to the manufacturer for further investigation. Examination of the left propeller revealed that both start lock stop pins were broken, and that the related area of the high pitch stop sleeve was damaged. The damage signatures and captured blade angles indicate that the engine was rotating and producing high power on impact. The nature of the damage indicated that the start locks were probably engaged and that the left propeller pitch was at its start lock position at the time of impact. This is not normal, and it was not determined why the start lock could have been engaged at the time of impact.

The right propeller did not sustain damage to the start locks. The blades showed a distinct power-on twist, although not to such an extent as the left propeller blades. Early separation of the propeller from the engine may have limited the power-on twist signatures of the right propeller blades.

On the ground, when the engine is idling, the propeller is on the low pitch stop of 13.2˚. During shutdown, as the propeller rpm decreases below 800, spring pressure overcomes centrifugal force and the start locks engage. The propeller blades then are free to coarsen by the action of the propeller feathering springs, from the low pitch stop of 13.2˚ to a point of between 17.2 and 20.2˚, at which point the start locks prevent further movement. After start up, the blades are driven towards the low pitch stop as oil pressure in the cylinder increases, thereby releasing pressure on the start locks. When the propeller rotation rises above 800 rpm, centrifugal force overcomes the spring pressure, extends the start lock pins, and moves them to an outward or retracted position. When the pins are retracted, the propeller blades are free to move throughout their full range of travel. The purpose of the start locks is to prevent the propeller from moving to the feather position after the engine is shut down, so as to reduce drag on the starter during engine start. An engaged start lock pin or pins would allow for blade angle travel between the low pitch stop position of 13.2˚ and the start lock position (17.2˚ to 20.2˚). A propeller with a blade angle at the start lock position will overspeed at certain combinations of engine power and aircraft speed.

The cockpit section of the aircraft, complete with the intact instrument panels, was shipped to the TSB Engineering Branch for further examination. Examination did not reveal any evidence of failure that might have resulted in electrical arcing prior to the impact. The engine and flight instruments were examined in an attempt to determine their indications at the time of impact; however, no useful information was found.

The vacuum-driven attitude indicator was refrigerated for two days at a temperature of -25˚C; it was then placed on a test bench and vacuum was applied to it. After a three-minute run-up, the indicator stabilized and performed to normal specifications. The background reference horizon and the white "lubber line" mark on the surrounding material and the adjustable aircraft symbol (which had not been adjusted after the occurrence) all coincided to indicate zero degrees of pitch.

1.12 Performance Issues

The maximum allowable take-off weight of the aircraft was 6,500 pounds. The take-off weight of the aircraft was determined to be about 5,800 pounds, and the centre of gravity was within the prescribed limits.

According to the aircraft's Pilot's Operating Handbook (POH), the aircraft's maximum rate of climb under the ambient conditions, with both engines operating, would have been 1,370 feet per minute (fpm). With one engine operating and the propeller of the other engine feathered, the maximum rate of climb would be about 410 fpm. According to the aircraft manufacturer, with one engine operating and the propeller of the other engine windmilling, the maximum rate of climb would be under 200 fpm, and if the aircraft were allowed to turn in the direction of the failed engine, the rate of climb would be nil.

Maximum climb performance is available only at the aircraft's best rate of climb airspeed. The performance section of the POH lists the best single-engine rate of climb airspeed under the occurrence conditions as 94 knots. The emergency procedures section of the POH indicates that in the event of an engine failure during climb, the pilot should maintain 97 knots. Deviation from the aircraft's best rate of climb airspeed will reduce climb performance.

According to the aircraft manufacturer's flight test data, at the accident aircraft's take-off weight, and at a pitch angle of 2.53˚, a constant airspeed of 115 knots will result in level flight, regardless of engine power. At pitch angles of more than 2.53˚, at 115 knots, the aircraft will climb, and at pitch angles of less than 2.53˚, at 115 knots, the aircraft will descend.

Calculations show that the length of the aircraft's flight path was about 6,000 feet, and at an average speed of 115 knots, the flight would have taken about 30 seconds. If the aircraft began turning as it passed over the departure end of the runway, then the average angle of bank required for the aircraft to reach the crash site would have been about 19˚.

An overspeeding propeller may produce reduced thrust, even though the engine may be producing power, if the blade angle is so fine that the propeller blade is not operating at a positive angle of attack. In that condition, the engine power would drive the propeller to a high rotational speed where the propeller tips exceed the speed of sound, and sonic drag absorbs some of the engine's power. The overspeeding propeller produces less drag than a windmilling propeller, and may produce thrust or drag, depending on propeller rpm and the aircraft's airspeed. The propeller manufacturer estimates that, in this case, if the propeller was on its start locks, it would have produced net thrust at all airspeeds up to and including 180 knots.

1.13 Aerodrome Information

The aerodrome elevation is 1,360 feet, about 60 feet above the elevation of the crash site on Wollaston Lake. The aerodrome is situated on the western edge of the settlement; therefore, after a night take-off on runway 34, there would be few lights visible to the pilot to use for visual reference.

1.14 Flight Recorders

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

1.15 Aircraft Equipment

The aircraft was normally equipped with seats for ambulatory passengers. For the occurrence flight, the seat backs were folded down and a stretcher from the Wollaston Lake nursing station, on which the patient was carried, was strapped on top of the seats, using the aircraft's seat-belts. The stretcher was an ABCO AF604 model, constructed of aluminum tubing and nylon cloth, incorporating two lateral restraint straps with an automotive-type buckle. There were no straps or other methods of restraint attached to the stretcher to prevent the forward movement of a stretcher occupant during deceleration. The aircraft's seat-belts restrained only the stretcher, and did not extend to the patient. The patient was positioned on her back with her head toward the front of the aircraft.

Air Navigation Order Series II, No. 2, provides that a passenger may be carried in a stretcher on an aircraft, provided the stretcher installation system is approved by Transport Canada.

An aircraft's stretcher installation system usually comprises a rack or other structure which attaches to hard points in the aircraft cabin and whose upper surface accommodates and secures a stretcher. An approved stretcher installation system may incorporate passenger restraint belts, but they are not mandatory. Transport Canada guidelines indicate that stretchers, aside from their installation systems, are not considered part of the aircraft and do not require approval prior to use in aircraft. Road stretchers are considered acceptable. The operator did not have approval to use the aircraft seats as a stretcher rack or stretcher installation system.

1.16 Training

The operator's Transport Canada approved syllabus requires the following training:

	Initial	**Recurrent**
General company procedures	4 hours	2 hours
Aircraft ground training	12 hours	5 hours
Surface contamination	required annually	
Emergency procedures	required annually	
Aircraft flight training	4 hours	1.5 hours

Amendment No. 7 to the syllabus provides that: "Captains with more than 50 hours on ME [multi-engine] aircraft with a current PPC need only complete the Recurrent Training." The operator's records indicate that the pilot completed the initial training as required by the training syllabus.

The pilot's previous employer operated the Piper PA-31 and PA-34 aircraft types and had authority from Transport Canada to group those two aircraft types for the purpose of pilot proficiency checks (PPC). The effect of such grouping is that a pilot may complete a PPC on each aircraft type in alternate years and retain PPC certification on both types, provided that the required recurrent ground training is completed. The pilot completed a PPC on the PA-31 type in July 1994. He completed a PPC on the PA-34 type in August 1995, and flew the PA-31 type at Eagle Air Services. A pilot's PPC remains current for one year from the end of the month in which the check is completed. When the pilot took up his employment with Eagle Air Services, he completed the required ground training and in each area of study completed the training to initial training standards, but he did not complete another PPC. Transport Canada's policy is that, after a change of the pilot's employment, a PPC which is renewed by an operator's grouping authority is only considered current if the new employer has an equivalent grouping authority. At the time of the occurrence, Eagle Air Services operated the PA-31 and not the PA-34, and did not have authority to group them. The operator reported that the regional Transport Canada, Air Carrier section was consulted at the time the pilot was hired, and that the operator was verbally advised that the pilot's existing PPC would remain valid despite his change of employment, provided the required company training was completed. Grouping authority is reportedly issued on request for most multi-engine aircraft types with maximum allowable take-off weights under 7,000 pounds.

The pilot's instrument rating was renewed in August 1995 and was valid until 01 September 1997.

Aircraft systems do not allow a propeller overspeed at take-off power to be readily demonstrated or simulated during training. Training on a flight simulator is the only effective way to train for a propeller overspeed emergency at take-off. A simulator is not available for the PA-31 aircraft type. The cockpit indication of a propeller overspeed is a higher-than-normal propeller rpm. The engine manifold pressure and the other engine indications may match those of a normal engine. The differential rudder pressure required to maintain directional control will probably be less than that required in the event of an engine failure, a condition which is commonly simulated during training. There is no direct cockpit warning of a propeller with start locks engaged.

Normal pre-take-off procedures require that a propeller check be performed to ensure that the propeller blades will move towards the feather position. The pilot reportedly completed this check during his aircraft run-up checks. The check can be accomplished within the range of propeller blade angle movement which is allowed by a stuck start lock.

1.17 Pilot Workload

Pilot workload and stress is at a peak during and shortly after take-off[4], particularly during single-pilot operations in instrument meteorological conditions. The pilot must adjust rapidly from visual to instrument conditions, and manage the aircraft systems to establish an angle and rate of climb to ensure a safe departure. Pilot workload and stress can be compounded by aircraft emergencies, adverse environmental conditions, and by concerns about passenger condition and comfort. Persons operating under conditions of high workload and stress can become task-saturated or overloaded, and may channelize their attention, concentrating on some tasks at the expense of others.

1.18 Survival Aspects

Nurses from the Wollaston nursing station are required to accompany patients on MEDEVAC flights, and the flight crews expect the nurses to secure patients to the stretchers on MEDEVAC flights. The nurses receive no specific training as to patient care techniques or passenger restraint on board a MEDEVAC aircraft, nor is such training required by regulation.

No pre-flight passenger briefing was provided by the pilot. The pilot believed that the passengers and nurse had flown with the operator before, that the nurse was well-versed on patient restraint issues, and that she would handle patient restraint tasks. In fact, the nurse had only arrived at Wollaston the previous day. When the pilot asked if passengers were restrained, he was told that they were. Air Navigation Order VII, No. 3 requires air operators to provide pre-flight passenger briefings to passengers. The captain of an aircraft has the ultimate authority and responsibility for passenger security.

The MEDEVAC was being conducted because of the patient's problems with her pregnancy. The pilot and the nurse were reluctant to restrain the patient over the abdomen, fearing that injury to the fetus might result from doing so. The nurse placed one restraining strap over the patient's lower torso. On impact, the patient's stretcher remained attached to the aircraft's seats, but the patient was thrown from the stretcher and struck the aircraft's interior and interior furnishings. She suffered a serious spinal injury. There was no injury to the fetus.

4 Earl L. Wiener & David C. Nagel, *Human Factors in Aviation* (San Diego: Academic Press, 1988)

1.19 MEDEVAC Standards

Several provinces set standards as to the medical evacuation of patients by air. The provinces of Ontario and Manitoba, for example, have legislation and regulations which require operators to meet certain, but differing, standards involving aircraft, passenger restraint, aero-medical equipment, ground facilities, and personnel training before conducting MEDEVAC flights. Operators who wish to organize flights for the provincial governments are required to meet the provincial standards. However, the standards are not imposed by the provinces on all operators who offer MEDEVAC flights. The standards are reportedly difficult to enforce in situations where the MEDEVAC flight is arranged or paid for by an organization other than an agency of the respective provincial government.

The occurrence flight was arranged by the Wollaston nursing station, an agency of Health Canada. Most Canadian aviation operation is regulated by the Government of Canada. There are no federal regulations requiring specific training for flight nurses accompanying patients on MEDEVAC flights.

2.0 Analysis

2.1 Flight Path

The pilot estimated the total flight time to have been about four seconds, and reported that he maintained the runway heading of 340° during the flight. However, the location of the wreckage indicates that, at the reported airspeed of 115 knots, the flight time was about 30 seconds, and the orientation of the wreckage trail indicates that the aircraft turned left through about 70° during that time.

2.2 Accident Sequence

Extensive examination revealed no evidence of cockpit electrical malfunctions or short circuits preceding the aircraft's impact with Wollaston Lake. Given the damage to the aircraft's electrical equipment and the tendency of electrical equipment to emit sparks and arcing sounds and smells during such damage, it is likely that the sparks and arcing sounds and smells reported by a passenger occurred during, rather than before, the impact sequence.

2.3 Engine and Propeller Status

Both propellers were rotating and both engines were producing power at the time of impact. However, it is likely that the left propeller start lock was engaged at the time of impact, and that the left propeller was restricted to the start lock position during the take-off sequence. There is no warning of the improper operation of the start locks that is evident to the pilot before the take-off roll. Because the propeller with the start locks engaged can absorb the engine's power at the beginning of the take-off roll, no abnormal engine or propeller indication would have been evident to the pilot until lift-off. At that time, increasing airspeed and the propeller's restricted range of pitch probably allowed the engine to go into an overspeed condition, where some of the engine's power was absorbed by propeller drag instead of being converted into thrust.

Because of the range of propeller pitch change possible with the start lock engaged, the pilot's pre-flight check might not reveal the left engine's stuck start lock condition.

2.4 Aircraft Performance

The aircraft manufacturer's data indicates that, with the right engine at take-off power, the aircraft was marginally capable of flight in the worst-case scenario: that is, with the left engine inoperative and the propeller windmilling. Although it is likely that the left engine was in an overspeed condition and producing little or no thrust, its engine and propeller were probably producing less drag than a windmilling propeller, and the aircraft should, therefore, have been capable of maintaining its altitude with right engine power after the left engine went into overspeed. However, the aircraft was allowed to turn, and, therefore, may not have been able to maintain its altitude. Because the runway was higher in elevation than the lake, no immediate climb was required.

The airspeed which the pilot reportedly maintained after take-off, 115 knots, was 18 knots higher than the emergency single-engine climb speed listed in the POH. Because maximum climb performance is available only at the best single-engine rate of climb airspeed (94 knots under the occurrence conditions), flying at an airspeed above 94 knots reduces the aircraft's available climb performance. Both engines were producing power, but, because the aircraft's climb angle was shallow, much of the engine power was initially converted to airspeed. Because the left engine was likely on its start locks, the increasing airspeed probably allowed the left engine rpm to increase to the point where some of its power was absorbed by propeller drag and not converted to thrust. The increasing rpm presented the pilot with an indication of a malfunction in one of the aircraft's powerplants. Because the cockpit indications of the malfunction were subtle, and propeller overspeed on take-off is difficult to simulate in training, the pilot probably became task saturated and was unable to readily resolve the situation.

2.5 Crew Issues

The pilot ground and flight training completed after the pilot's arrival at Eagle Air Services was done to "initial training" standards, but no PPC ride was done. Therefore, although the pilot's PPC on the accident aircraft type was current for both the PA-31 and PA-34 aircraft types while he was with his previous employer, and would have remained current there until 31 August 1996, it was not, according to Transport Canada policy, current at Eagle Air Services. However, the operator reportedly received verbal advice that the grouped PPC would remain in effect, and relying on that advice, did not schedule a new PPC for the pilot. Because he flew the PA-31 type at Eagle Air Services, the pilot maintained the continuity of his PA-31 flying from the time of his change of employment to the time of the occurrence.

The engine overspeed emergency faced by the pilot just after take-off was subtle and difficult to analyze, because the engine sounds and cockpit and engine indications would not have been as dramatic as those of an engine failure. Because of the limited thrust still being produced by the left engine, the rudder pressure required to maintain directional control would not have been as great as the pilot would have experienced during engine failure demonstrations during his training. As well, the pilot's elevator trim setting procedure required that he apply a slight amount of back pressure to the controls to maintain level flight. This may have added to the pilot's workload during the occurrence.

Manufacturer's flight test data indicate that if the pilot had maintained his reported airspeed of 115 knots and wings-level, 9˚ nose-up attitude, the aircraft should have climbed. However, the aircraft turned, and descended and struck the lake's surface in a different attitude. The pilot's reported perceptions, therefore, differ significantly from the physical evidence. Shortly after take-off, the pilot was confronted with a confusing aircraft emergency under adverse operational and environmental conditions. In this situation, the difference between the pilot's perceptions of the flight and reality indicate that the pilot probably became overloaded and his attention became channelized, and he was unable to prevent the aircraft from striking the surface.

2.6 Patient Restraint

Though the operator did not have Transport Canada approval to use the aircraft's seat-belts to secure the stretcher, the stretcher remained secured during the occurrence, and the method of stretcher installation, therefore, did not contribute to the patient's injuries.

The patient's one restraining strap, which was part of the stretcher accompanying her from the nursing station, was insufficient to secure her to the stretcher during the impact sequence. Because Transport Canada does not consider patient stretchers to be part of the aircraft in which they are used, they are not regulated, and neither their materials nor their construction are required to conform to aircraft standards.

2.7 MEDEVAC Standards

Although the nurses from the Wollaston nursing station were required to attend to patients' medical needs on MEDEVAC flights and ensure that patients were secured to their stretchers in flight, they had no training in MEDEVAC operations, nor is any such training required by federal aviation regulation.

A number of provinces have standards for the operation of MEDEVAC flights, but the standards are only selectively enforced. Because most aviation is federally regulated, provinces have difficulty enforcing their regulations when the MEDEVAC flight is not arranged by a provincial agency. Because many MEDEVAC flights from remote areas are arranged by a federal agency, provincial regulations governing MEDEVAC flights are often not observed.

3.0 Conclusions

3.1 Findings

1. The aircraft was airborne for about 30 seconds after departure from runway 34 at Wollaston Lake airport and, during that time, completed a left turn of about 70°.

2. It is likely that the sparks and electrical arcing sounds and smells reported by a passenger in the aircraft occurred during, rather than before, the impact sequence.

3. The pilot did not complete a PPC on the accident aircraft type within the 12 months before the occurrence, but Transport Canada reportedly advised the operator verbally that the pilot's PPC would continue in effect.

4. The left propeller probably became fixed at the start lock position during the take-off acceleration phase, and went into an overspeed condition as the airspeed increased after lift-off.

5. In the overspeed condition, some of the left engine's power was absorbed by propeller drag and was not converted to thrust.

6. The cockpit indications of a propeller overspeed at take-off cannot readily be simulated in training, and are more subtle than those of an engine failure.

7. The pilot probably became task saturated while attempting to determine the cause of the propeller overspeed, and his attention became channelized.

8. The pilot did not provide a pre-flight briefing to the passengers before take-off.

9. The operator's method of securing the stretcher to the aircraft, though unapproved, did not contribute to the patient's injuries.

10. The restraining strap on the stretcher provided for the patient was insufficient to secure her to the stretcher during the impact sequence.

11. The design and security of stretchers used in aircraft are not regulated by Transport Canada, and are not required to conform to aircraft standards.

12. The company operations manual and company training programs contained no direction as to air ambulance operational procedures.

13. There are no federal aviation standards as to aircraft, equipment, or personnel training specifically for the operation of MEDEVAC flights.

14. Provincial regulations covering MEDEVAC operations are difficult to enforce where a MEDEVAC flight is not arranged by a provincial agency.

3.2 Causes

After take-off, the left propeller was likely on its start locks, which, as the airspeed increased, allowed the propeller to overspeed. The pilot was unable to resolve the situation in time to prevent the aircraft from striking the surface of Wollaston Lake. Contributing to the severity of the patient's injuries were the inadequate restraint provided by the stretcher and its restraining strap, the lack of standards regarding stretchers used in aircraft, and the lack of standards as to the operation of MEDEVAC flights.

4.0 Safety Action

4.1 Action Taken

4.1.1 *Stretcher Installations and Patient Restraints*

During this investigation, it became evident that the Air Navigation Order (ANO) concerning the installation of a stretcher, incubator, or similar device in an aircraft (ANO Series II, No. 2, subsection 4(2)) was open to different interpretations. The ambiguity could have resulted in the approval of an installation which negated the airworthiness of both the device (e.g., stretcher) and patient restraint. This shortfall has been redressed by Canadian Aviation Regulations (CAR) subsection 605.23, which states that each person carried on a stretcher, in an incubator, or other similar device must be provided with a "restraint system." Such a "restraint system," under the provisions of CAR 605.06, *Aircraft Equipment Standards and Serviceability*, must meet applicable standards of airworthiness (i.e., the equipment and its installation must be approved by Transport Canada).

Additionally, Transport Canada (TC) has taken action to update its air ambulance-related publications (*Guide to Air Ambulance Operations*, TP 10839E and *Stretcher Installation in Aircraft*, ASI 32) to reflect the changes brought about by the introduction of the CARs.

4.1.2 *Dissemination of Information*

The Board believes that those agencies involved in contracting for air ambulance services should be made aware of the safety issues identified during this investigation. As such, the final report on this occurrence investigation is being distributed to the appropriate authorities in the federal government as well as all provincial and territorial governments.

4.2 Action Required

4.2.1 *Regulatory Overview of Air Ambulance Operations*

The term "air ambulance operations" refers to the transport of medical patients by air. The missions can range from a straightforward patient transfer to an emergency medical evacuation (MEDEVAC). At present, air ambulance operations are considered by TC to be a commercial air service and as such are governed by Part VII of the CARs. The granting of an Air Operator Certificate, which allows for the transport of fare-paying passengers, also permits the operator to adapt the operation for an air ambulance service. The CARs contain no specific reference to or standards with respect to the conduct of air ambulance operations, and conducting such a service does not require an amendment to the Operations Specification. As such, TC might not be aware that an operator is conducting an air ambulance service and, therefore, might not include aspects specific to air ambulance operations in any TC audit and surveillance of the operator.

TC currently relies on operators to voluntarily make the necessary changes to aircrew training and operational procedures, and to seek TC airworthiness approval of equipment installations before offering air ambulance service to the public. However, in this occurrence, the operator was conducting an air ambulance service without a TC-approved stretcher installation, additional aircrew training, and amended manuals to reflect specific air ambulance procedures.

As noted earlier, several provinces have set standards for aircraft, passenger restraints, aero-medical equipment, ground facilities, and personnel training. However, these standards are reportedly difficult to enforce in situations where the flight is arranged or paid for by an organization other than an agency of the respective provincial government.

As recognized in Transport Canada's air ambulance guidance documents and in the efforts by some provincial governments to regulate the air ambulance services in their respective provinces, the provision of consistently safe air ambulance service requires equipment, training, and procedures considerably different from those required for regular passenger-carrying operations. The Board understands that in other occurrences (e.g., TSB A89O0280), patient safety has been compromised by inadequate protective measures (vis-à-vis those afforded a normal passenger). Notwithstanding measures taken by some provinces to enhance patient safety in air ambulance operations, the Board believes that a consistent level of safety across Canada will not be attained through voluntary measures. Crews and patients will remain at risk to the extent that patients are transported with inappropriate equipment or by crews that have not been adequately trained in meeting the special needs of non-ambulatory medical patients. Therefore, the Board recommends that:

> The Department of Transport require all air carriers operating air ambulance services in the course of their business to provide the equipment, procedures, and crew training necessary to ensure a level of safety for patients consistent with that provided by commercial air services to fare-paying passengers.

A97-01

4.3 Safety Concern

The Board is concerned that the continuing involvement of MEDEVAC and air ambulance flights in accidents is disproportionate to the activity rate. Too often, patients become victims of air accidents, as in this accident.

In a previous occurrence report involving a MEDEVAC, the Board wrote:

> Between 1976 and 1994, there were 38 occurrences involving aircraft engaged in air ambulance or medical evacuation flights. Fifteen of these accidents took place in Canada's designated North.... Twenty-one of the MEDEVAC accidents occurred during VFR flights, and 18 occurred on dark nights (i.e. notwithstanding reported flight visibility conditions, the absence of ambient lighting, either from surrounding built-up areas or from the moon, created extra problems for conducting flight by visual outside reference). Twelve of the 38 MEDEVAC accidents were CFIT [controlled flight into terrain] accidents, which occurred at night.
>
> This accident at Kuujjuaq underlines the Board's earlier concern in that MEDEVAC flights may be conducted on an *ad hoc* basis without operators having met any particular standards for conducting such flights in the harsh physical environment of the Arctic. (TSB A94Q0182)

This accident at Wollaston Lake also raises questions as to the adequacy of the regulatory oversight for the maintenance of safety standards for air ambulance operations.

Although this accident involved a commercial air service, approximately 12% of air ambulance occurrences involve "State-owned" aircraft, usually on behalf of a provincial government. The Board has previously made observations on the different level of safety that is required for such state-owned operations, vis à vis that required for commercial air services. For example, a recent Board report (TSB A93Q0245) stated:

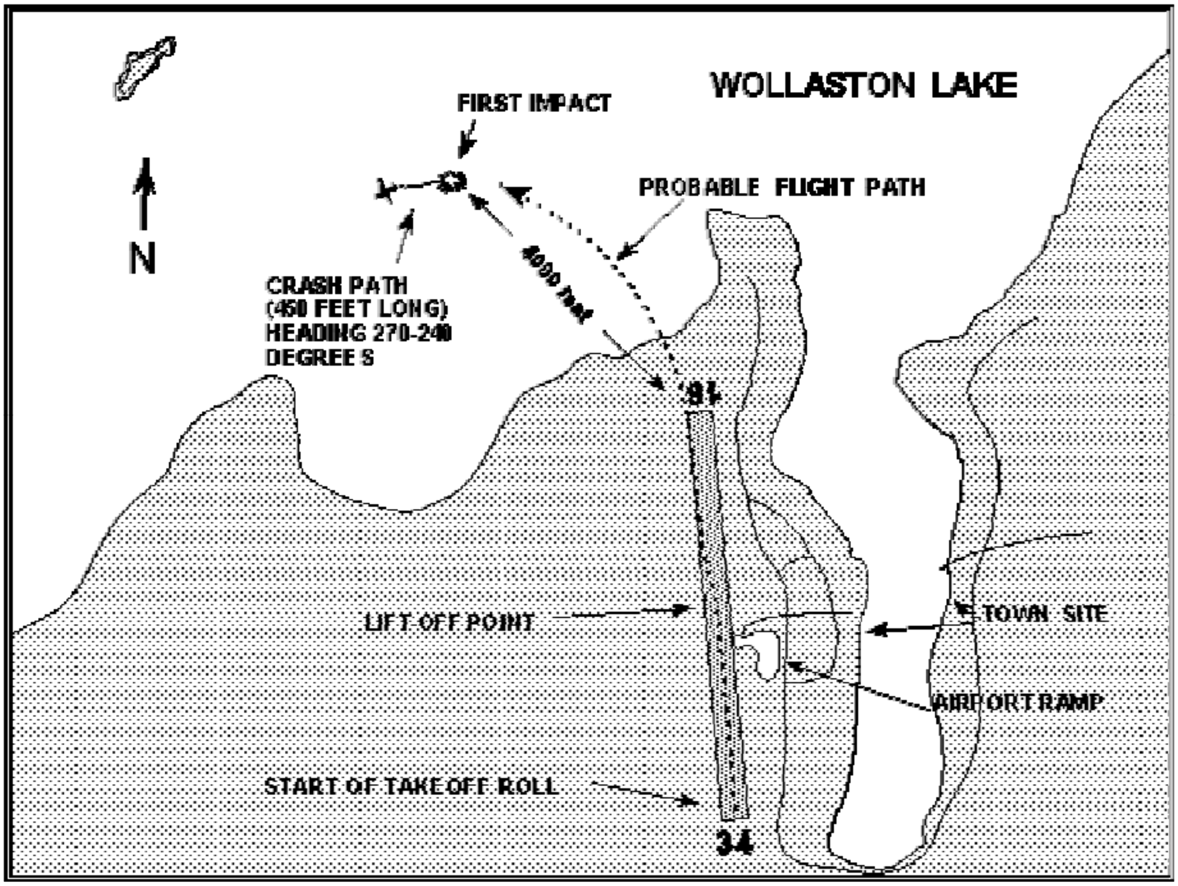
> ...when passengers are regularly carried on state aircraft, it is reasonable for these passengers to expect that the aircraft and the aircrew involved in state operations are subject to the same regulatory requirements as commercial carriers.... Therefore the Board recommends that:
>
> > The Department of Transport require that the operators of state aircraft be subject to regulatory overview, as practicable, equivalent to that of similar commercial operations.
> > (A96-03, issued April 1996)

In essence, Transport Canada rejected this recommendation.

Although the Board finds no particular fault with state-owned air ambulance services at this time, it remains concerned about continuing disparities between state and commercial operations in the levels of safety offered. The Board is not making a further recommendation in this regard as a result of this accident involving a commercial aircraft. Nevertheless, it is for consideration that any differences in safety standards between state and commercial air services with respect to the conduct of air ambulance operations should be eliminated.

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 12 May 1997*.

Appendix A - Flight Path



Appendix B - List of Supporting Reports

The following TSB Engineering Branch Reports were completed:

LP 194/95 - Electrical System Examination; and
LP 29/97 - Examination of Propeller Start Lock Pins.

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

Appendix C - Glossary

AES	Atmospheric Environment Service
agl	above ground level
ANO	Air Navigation Order
asl	above sea level
ATPL	Airline Transport Pilot Licence
CAR	Canadian Aviation Regulation
CFIT	controlled flight into terrain
CST	central standard time
fpm	feet per minute
knots	nautical miles per hour
lb	pound(s)
MEDEVAC	medical evacuation
nm	nautical miles
POH	Pilot's Operating Handbook
PPC	pilot proficiency check
rpm	revolutions per minute
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VFR	visual flight rules
'	minute(s)
"	second(s)
°	degree(s)