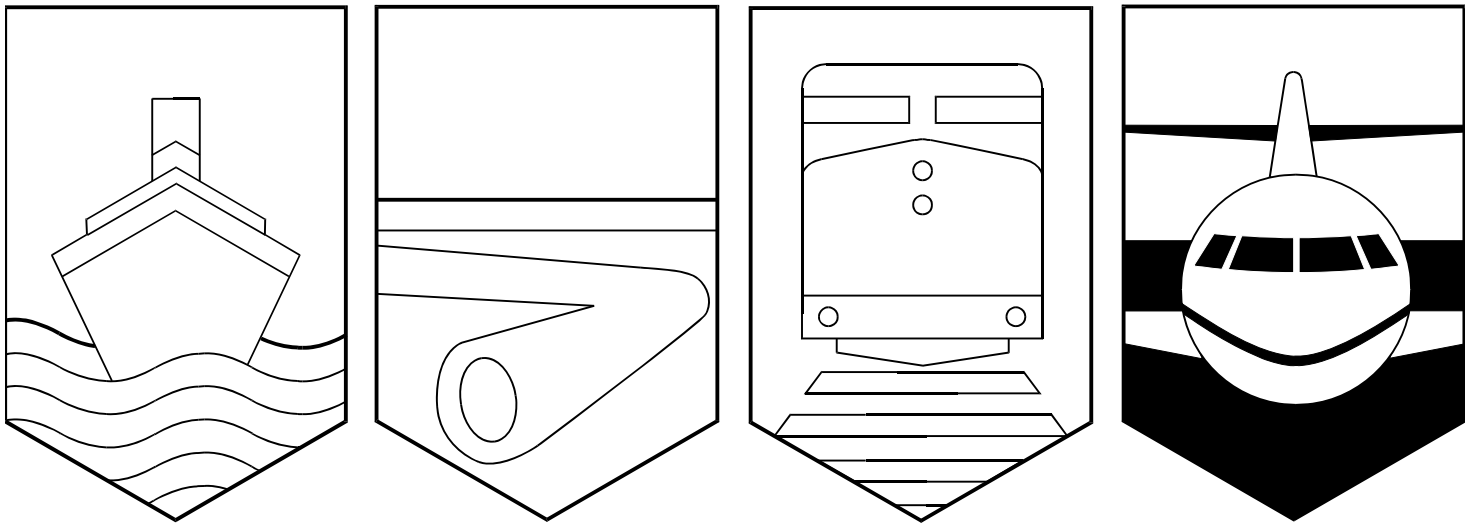
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada



AVIATION OCCURRENCE REPORT

COLLISION WITH SURFACE OF ICE

TRANS-CÔTE
PIPER PA-31-310 C-GDOU
STRAIT OF BELLE-ISLE, QUEBEC
11 JANUARY 1994

REPORT NUMBER A94Q0002

Canada

MANDATE OF THE TSB

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, 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. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

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Aviation Occurrence Report

Collision with Surface of Ice

Trans-Côte
Piper PA-31-310 C-GDOU
Strait of Belle-Isle, Quebec
11 January 1994

Report Number A94Q0002

Synopsis

The crew departed St. Anthony, Newfoundland, on a night visual flight rules (VFR) flight to Lourdes-de-Blanc-Sablon, Quebec. Radio contact with the aircraft was lost after the crew reported that they were on final approach to their destination. Two days later, some debris from the aircraft was found drifting on the ice, but a further search was unsuccessful. About seven months after the occurrence, a trawler recovered the tail section of the aircraft. Neither pilot has been found.

The Board was unable to determine the cause of the accident; however, it is probable that the pilots did not monitor the altimeter properly and allowed the aircraft to descend until it struck the surface of the ice.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

On 11 January 1994, the crew were on a chartered round-robin flight on a PA-31 Navajo, between Lourdes-de-Blanc-Sablon airport, Quebec, and St. Anthony, Newfoundland, in accordance with visual flight rules (VFR)[1]. During the return flight, at night, the crew advised the St. Anthony flight service station (FSS) that they departed at 1813 Newfoundland standard time (NST)[2]. At 1846 NST, the crew transmitted that they were flying at 2,500 feet and that they were 32 nautical miles[3] (nm) and 13 minutes southeast of Blanc-Sablon. Seven minutes later, the crew called the Sept-Iles FSS through the Blanc-Sablon repeater. They requested airport information and reported being 16 nm and six minutes from the airport.

After receiving information on the winds and the altimeter setting, the crew reported that they would use runway 05 and would call back on final. No further transmissions were received from the crew.

1 See Glossary for all abbreviations and acronyms.

2 All times are NST (Coordinated Universal Time [UTC] minus three and a half hours) unless otherwise stated.

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

Aircraft parts matching C-GDOU were found on drift ice on 13 January by a Canadian Forces search and rescue helicopter. Sonar scanning failed to locate the main wreckage, but the aircraft tail and some other components were recovered by a scallop trawler in early August. The bodies of the two occupants have not been found.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	2*	-	-	2
Serious	-	-	-	-
Minor/None	-	-	-	-
Total	2*	-	-	2

* missing and presumed dead

1.3 Damage to Aircraft

The aircraft was not recovered in its entirety. Only about 30 pieces and components were recovered from the ice surface by the crew of a Canadian Coast Guard vessel. The tail was brought to the surface by a trawler. With the small number of parts recovered, it was not possible to determine all the damage to the aircraft. However, with the parts available, it was established that the aircraft cabin broke up and that the fuselage was broken at the height of the rear door.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

	Captain	First Officer
Age	31	26
Pilot Licence	ATPL	CPL
Medical Expiry Date	13 Oct 95	5 Oct 95
Total Flying Hours	8,000	1,079
Hours on Type	1,550	650
Hours Last 90 Days	197	181
Hours on Type Last 90 Days	N/A	165
Hours on Duty Prior to Occurrence	2	6
Hours off Duty Prior to Work Period	4	15

1.5.1 Pilot-in-Command

The pilot was certified and qualified for the flight in accordance with existing regulations. He had a great deal of flying experience in the region as a bush pilot. He had been flying the Navajo for three years, was qualified as a chief pilot by Transport Canada, and had held this position in the company for the past two years. He received very high praise for his performance during his last check rides with Transport Canada on the Navajo and King Air.

There was no evidence that incapacitation or physiological factors affected the pilot's performance. A passenger who disembarked at St. Anthony said the pilot-in-command occupied the left seat when they departed St. Anthony.

1.5.2 Co-pilot

The co-pilot was certified and qualified for the flight in accordance with existing regulations. He had only a few years' experience in aviation, but, by making himself available to the company for all flying opportunities, he had earned his qualifications on the Navajo and King Air. He had a reputation for following regulations and had successfully completed his pilot proficiency checks (PPC) with Transport Canada. This flight was, in principle, to be the co-pilot's last before being laid off. This lay-off was seasonal and had already been delayed because of an unexpected busy period.

There was no evidence that incapacitation or physiological factors affected the co-pilot's performance.

1.6 Aircraft Information

Manufacturer	Piper
Type and Model	PA-31-310 Navajo
Year of Manufacture	1976
Serial Number	31-76-12033
Certificate of Airworthiness (Flight Permit)	Valid
Total Airframe Time	11,050 hr
Engine Type (number of)	Reciprocating (2)
Propeller/Rotor Type (number of)	Hartzell (2)
Maximum Allowable Take-off Weight	6,500 lb
Recommended Fuel Type(s)	Avgas 100 LL
Fuel Type Used	Avgas 100 LL

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The weight and centre of gravity of the aircraft were within the prescribed limits at the time of the accident.

Except for the autopilot, which had been inoperative for some time, the review of the aircraft log and technical logs revealed no evidence of any deficiencies that could have been a factor in the occurrence. Regulations did not require that the aircraft be equipped with an autopilot for this type of flight.

There was no evidence found that airframe failure or system malfunction was the initiating event in this accident.

1.7 Meteorological Information

According to the weather information provided by the Blanc-Sablon FSS, there was scattered cloud at 2,500 feet and visibility of 15 miles. The temperature was minus 13 degrees Celsius and the winds were from 315 degrees magnetic at six to eight knots. The altimeter setting on departure from Blanc-Sablon and St. Anthony was 30.17 inches of mercury (in. Hg) and was unchanged for the return flight.

According to eye witnesses, the night was clear and the Newfoundland coast, at a distance of 10 to 15 nm, was easily discernible. The moon was in the new phase and was not visible. A pilot who conducted a search flight over the Strait of Belle-Isle immediately after the aircraft was reported missing reported that the flight conditions were excellent.

1.8 Aids to Navigation

The distance measuring equipment (DME) of the Blanc-Sablon airport was not functioning at the time of the accident. However, a DME is not required for VFR flight.

The aircraft was equipped with a global positioning system (GPS) receiver, and its regular use was part of the standard operating procedure (SOP) of the company. The aircraft was not equipped with a ground proximity warning system (GPWS), nor was such a system required by regulations.

1.9 Communications

On departure from St. Anthony, the crew communicated with the FSS specialist. They stated their intention to fly at an altitude of 2,500 feet as per their flight plan, and they requested departure information. They were informed of the winds, the runway in use, and the altimeter setting of 30.17 in. Hg.

The crew then reported their take-off time as 1813. At 1846, the crew reported being at 2,500 feet and 32 nm southeast of Blanc-Sablon. They estimated arriving at their destination in 13 minutes.

Seven minutes later, 11 activations of the radio transmitter on frequency 122.0 were heard. To illuminate the approach and runway lights, the transmitter must be activated at least seven times in five seconds. A few seconds later, the crew contacted the Blanc-Sablon FSS to ask for airport information. The voice of the person transmitting this request was identified as that of the co-pilot. There was no mention during this transmission of any difficulty in illuminating the lights. No further transmitter activation sequences were heard, and no problems with the lights were reported by aircraft landing later at Blanc-Sablon. Communications on the Blanc-Sablon frequency are transmitted to the Sept-Iles FSS by telephone line.

At 1853, the co-pilot transmitted that the aircraft was 16 nm southeast of Blanc-Sablon, and that they estimated arriving in six minutes. The aircraft's altitude was not mentioned during this transmission. The Sept-Iles FSS advised the crew that the winds were from 330 degrees at 10 knots and the altimeter setting was 30.17 in. Hg. At 1854, the co-pilot indicated that they would use runway 05 and would call back on final.

The FSS specialists and some co-workers of the co-pilot who are accustomed to hearing the co-pilot's voice listened to the recording of the radio transmission, and indicated that his voice sounded normal and exhibited no signs of anxiety. No difficulties were reported by the crew.

The FSS attempted to contact the aircraft several times between 1903 and 1908, but was unsuccessful. There were no further transmissions from the C-GDOU crew.

1.10 Route

The way-point coordinates for Blanc-Sablon airport as programmed on the aircraft GPS were those of the "BX" non-directional beacon (NDB). The GPS navigates according to the shortest route between two points. All indications are that the crew followed a direct route from St. Anthony to Blanc-Sablon. This route crosses the Labrador coast between Anse-au-Clair, Quebec, and Forteau, Quebec, about 10 nm southeast of Blanc-Sablon.

Distance/time calculations indicate that, when the crew reported being 32 nm and 13 minutes from Blanc-Sablon, the ground speed of the aircraft was 150 knots. The crew reported their altitude as 2,500 feet. Calculations indicate that their ground speed was 160 knots when the co-pilot reported 16 miles and six minutes from Blanc-Sablon. The wind factor at altitude over such a short distance is negligible.

When making a VFR approach to the Labrador coast with runway 05 selected, company crews normally bear left to better position themselves for the final approach. The resulting flight path describes an arc that, from east to west, overflies île au Bois, Quebec, and île Verte,

Quebec. This arc passes about one and one-half miles from the Labrador coast and about nine miles from Newfoundland.

There is a lighthouse with a white light on île Verte. There are no lights on île au Bois. The elevation of île Verte is 50 feet above sea level (asl), and that of île au Bois, 150 feet asl. Both islands were covered with snow and provided no significant contrast with the surface of the ice.

1.11 Flight Recorders

The aircraft was not equipped with flight recorders. Existing regulations did not require flight recorders on this type of aircraft.

1.12 Wreckage and Impact Information

Two days after the accident, several pieces of the aircraft were found on drift ice, but not on the intended route of the aircraft. By the following morning, when the pieces were recovered, they had drifted with the ice and were six miles from the position where they were initially located.

One of the pieces found was the fibreglass nose cone of the aircraft. Damage was concentrated on the underside and aft portions of the nose cone; the forward area was intact. The upper structure of the baggage compartment and several components from that area were also recovered. The other pieces found were from the cockpit, wing roots, and cabin ceiling. A few small pieces and hoses associated with the engines were also recovered. The parts that were found on the ice originated in about equal numbers from both sides of the aircraft.

Pieces of the interior cabin wall were brought to the surface on 07 August by a scallop trawler. The next day, the trawl of the same vessel snagged the aircraft's tail. The load was initially too heavy for the winch. When the tension suddenly released, the fishermen thought the entire assembly had disengaged, but the tail was still snagged.

The tail was damaged by the trawl during recovery. The appearance of the recent damage contrasted with that of the damage caused by the accident, the older damage having been altered by prolonged exposure to salt water.

The aluminum skin under the tail was bulged upward between the ribs. This type of deformation is caused by the force of impact with the water, and is often seen on the underside of floats that have struck the water hard in a floatplane accident.

The upper part of the vertical stabilizer leading edge was bent toward the left side of the aircraft, and the lower part was shredded. This damage line extended to a second break in the fuselage just forward of the vertical stabilizer. The outboard leading edge of the left horizontal stabilizer was also bent downward. The damage to the vertical stabilizer, the break in the fuselage, and the angle of the bend in the left horizontal stabilizer all lie in an arc that could have been described by the right wing as it was folded back. The characteristics of this damage are consistent with an impact with a surface corresponding to the leading edge of a wing.

The break in the fuselage at the height of the cabin door, where the structure is affected by the contour of the door, often occurs during impact where the deceleration is very rapid. The second break in the fuselage, forward of the vertical stabilizer, where the reinforcing ribs converge, is less likely to have been caused by impact forces alone.

Half of both elevators and the upper part of the rudder were missing. The rivets attaching them to their hinges had been pulled out. There was no sign of blackening around the rivet heads, which would have suggested movement in the rivets. The rudder tab hinges had failed. The tab remained attached to the rudder only by its control rod. There were no signs of abrasion or hammering on either surface of the tab. The fracture surfaces on the hinges had been affected by exposure to water, but the 45-degree angle at the edge of the break indicated failure in overload.

1.13 Eye Witnesses

A white light, corresponding to the light mounted on the tail of C-GDOU, was seen by four witnesses at three different locations. In two of these cases, the time of the sighting coincided with the time at which the aircraft would have passed the witness' location.

One witness followed the light for about two minutes. He stepped out of his house at the back of the bay at l'Anse-au-Clair to get a better view. He thought it was unusual that the light, which was moving at a speed consistent with that of an aircraft, was flying at such a low altitude. The witness was about 100 feet above water level. Given his line of sight and the height of the mountains around the bay, he estimated the aircraft to be about 300 feet above ground level (agl). It appeared to him that the aircraft was flying parallel to the surface of the water until he lost sight of the light behind a mountain.

Two other witnesses were on the road one-half mile from the coastal ridge and at an altitude of 300 feet asl. Their observation was limited to only five or six cycles of light intensity changes (one cycle lasts about one second). The witnesses stated that the light was lower than their position and was falling from the sky. They lost sight of the light behind the coastal ridge.

Another witness was driving towards Blanc-Sablon from Bras-d'Or, Quebec, when he saw the landing lights of an aircraft. He could not estimate its altitude because of the darkness. After looking at the road, he again looked toward the aircraft and saw the reflection of the light on the surface of the ice.

None of the witnesses saw the aircraft touch the surface of the water.

1.14 Fire

There was no evidence of fire on the pieces recovered.

1.15 Survival Aspects

The various pieces recovered indicate that the cabin had broken up completely; sections of seat rail from the cockpit were found broken. Due to the magnitude of the deceleration forces and the immersion of the occupants in ice-cold water, the accident was considered to be non-survivable.

1.16 Tests and Research

Since the ice drifted towards the north shore and blocked off the accident area, no underwater searches could be conducted in the weeks following the accident. An underwater search finally commenced in mid-July (see Laboratory Report LP 097/94). Side-scan sonar was used to view the sea bed in the area indicated by the witness who saw light on the ice, but to no avail.

On 07 and 08 August, a trawler equipped with a scallop trawl was dragging an area just south of the sonar search zone and recovered several pieces of the cabin interior wall covering and the complete aircraft tail. Sonar scanning was resumed in this area but the aircraft was not found (see Laboratory Report LP 125/94).

1.17 Approach to Uncontrolled Aerodromes

The *Aeronautical Information Publication* (AIP), at section 4.5.2 of "Rules of the Air," states that aircraft on VFR approach to an uncontrolled aerodrome normally should join the aerodrome circuit on the downwind leg or enter the crosswind leg at an altitude of 1,000 feet above the runway.

According to the recommendation of the AIP, an approach to the Blanc-Sablon airport with a reference point altitude of 121 feet asl would have brought the crew to overfly the airport at an altitude of 1,121 feet before they joined the downwind leg.

1.18 Additional Information

1.18.1 Altimeter Reading

The aircraft was equipped with two altimeters with traditional graduated scales. The instruments have three needles: a small needle indicating tens of thousands of feet, a medium-size needle indicating thousands of feet, and a long needle indicating hundreds of feet. The fact that there are three needles could cause the pilot to make an erroneous reading of the instrument.

An accurate indication of the altitude above sea level can be obtained only if the current altimeter setting is displayed in the setting window of the instrument. The barometric pressure was the same at Blanc-Sablon and St. Anthony.

1.18.2 Visual Perception

When making a daytime descent to an airport, pilots use their depth perception to estimate their altitude and distance from the airport.

During a night descent, because of the lack of references from terrain details and the lack of colour variations and shadows, pilots are deprived of the cues they need to perceive depth. Because there are few visual references available, the pilot may have difficulty in judging his height, distance, speed and acceleration. What is perceived outside the aircraft must be validated by instrument readings.

The aircraft was flying at night, in a descent, above an ice-covered surface. In addition, the faint light from the new moon was diffused by a layer of scattered cloud at 2,500 feet. The contrast between the horizon and the sky was weak and provided no cues to changes in the aircraft's attitude. Lights were visible in the houses on both coasts to either side of the aircraft.

During night approaches with unlimited visibility, approach lights, runway lights, and lights from inhabited areas can appear brighter than they really are. This can make pilots think they are closer to the runway or coast than they actually are, thus creating the impression that they are at a higher altitude and inducing them to descend lower than they should.

1.18.3 Teamwork

The pilots had received training in pilot decision making (PDM). Another course called Cockpit Resource Management (CRM) is also available. The aim of flying with a two-person crew is to provide cross-checks and to ensure that one pilot will correct the errors and lapses of the other. The CRM course develops the pilot's ability to apply this concept. The pilots had not received CRM training.

It is normal for the pilot not flying the aircraft to perform radio communications. It was established that the co-pilot made the last radio communications.

1.18.4 Attention/Vigilance

Both pilots were qualified on the aircraft. The airport was their base of operations, and they had made several night approaches to it.

The weather was fine, all was proceeding normally, the flight was being conducted in accordance with visual flight rules, and the pilots were undertaking an approach to the airport with which they were most familiar. The crew had every reason to feel at ease, and nothing required their vigilance in any particular way.

1.19 Useful or Effective Investigation Techniques

Studying similar accidents permits comparisons with the causal elements in this occurrence.

One similar occurrence involved a Canadian Forces four-engine Hercules aircraft that struck the ground 12 miles from Alert, in the Northwest Territories, during a night approach. The aircraft was following another aircraft,which landed without difficulty. The statement of one of the pilots confirmed that the crew inadvertently allowed the aircraft to descend until it struck the ground.

2.0 Analysis

2.1 The Flight

The crew were qualified for the flight, the weather was favourable for the flight, and there were no problems reported with the aircraft.

The crew were also familiar with the airport. This very probably explains why they decided to make a straight-in approach rather than fly a circuit as recommended in the AIP.

The accuracy of the distances and flight times transmitted by the crew indicates that they were using the GPS as an aid to navigation, particularly in view of the fact that the Blanc-Sablon DME was not in service at the time of the occurrence.

Speed calculations indicate that, when the co-pilot transmitted their position as 16 miles and six minutes from the airport, the descent had probably commenced. Though their position and time of arrival were mentioned, their altitude was not. This indicates either that the crew felt very comfortable with their altitude or that they had not checked their altitude with the same degree of care as they had checked their GPS data. The altimeter setting was the same throughout the flight; it is plausible that the correct setting was displayed on the instrument, and that a correct reading of aircraft altitude was possible. It was not necessary to do a reset or to visually check the barometric scales to confirm the position or cause the crew to look at the altimeter.

Another possibility is that the pilot who was monitoring the altitude misread the altimeter.

2.2 Visual Contact

The normal route of the aircraft passed to the east of île au Bois, at the location and time that the witnesses saw the flashing light. At that location, the altitude of the aircraft was unusually low.

The analysis of the pieces recovered from the aircraft does not indicate an uncontrolled descent. It is probable that the witnesses on the mountain got the impression that the light was falling because of their angle of view.

The witness travelling from Bras-d'Or saw the aircraft just before and after the impact. The pieces of the aircraft were found very close to the coordinates he provided. As this witness saw the lights against a black background, he was unable to estimate the altitude of the aircraft.

2.3 Night Vision

It is probable that the pilot flying the aircraft at the time of the accident could see the airport and the town of Lourdes-de-Blanc-Sablon in the distance. However, the human eye requires references like nuances of colour and shadow or details of relief to aid in judging distance and depth. In darkness, the eye cannot perceive these details; thus, our ability to judge heights is adversely affected.

2.4 Communications

The fact that the witnesses saw the aircraft light indicates that the aircraft's electrical system was functioning and capable of powering at least one of the two radio transmitters.

The normal tone of the co-pilot's voice and the absence of a distress call, at a time when the aircraft was at an unusually low altitude, indicate that the pilots were not aware that they were in a hazardous situation.

2.5 Vigilance

It is plausible that the favourable weather, the pilots' familiarity with the airport, and the normal routine of the flight reduced the level of crew vigilance and did not prompt the pilots to validate their visual cues using the aircraft instruments.

2.6 Impact Characteristics

Due to the uneven surface of the ice and the limited number of aircraft parts available, the angle of impact could not be determined.

There was no evidence that the flight control surfaces failed in flight because of metal fatigue. It is highly improbable that the elevators and rudder failed at the same time.

It is also improbable that the rudder tab would remain attached in flight if it was held only by its control rod. Moreover, the movements of the tab would have caused it to hammer against the adjacent surfaces, but that did not occur.

Although it is plausible that the right wing folded back and caused the observed damage to the vertical stabilizer, fuselage, and horizontal stabilizer, the wing folded back during the impact. Catastrophic failure of the wings or the loss of the ability to command the flight control surfaces will cause the aircraft to descend in an abnormal position, usually in a dive.

The absence of damage to the front of the nose cone and the deformation of the skin under the tail are more indicative of impact in controlled flight with a pull-up at the last moment.

3.0 Conclusions

3.1 Findings

1. The crew were certified and qualified for the flight in accordance with existing regulations.

2. The aircraft was certified, equipped, and maintained in accordance with existing regulations.

3. There was no evidence found to suggest that there was an airframe failure or system malfunction prior to or during the flight.

4. Witnesses observed the aircraft flying at an unusually low altitude.

5. The altimeter setting was the same as for the previous flight.

6. The altitude was not reported on the approach to the destination.

7. No distress calls were transmitted.

8. At night, it is possible to misjudge the height of an aircraft with reference to the ground or a frozen surface.

3.2 Causes

The cause of the occurrence could not be determined; however, it is probable that the pilots did not monitor the altimeter properly and allowed the aircraft to descend until it struck the surface of the ice.

4.0 Safety Action

4.1 Action Taken

4.1.1 Accidents Involving Controlled Flight into Terrain

The circumstances of this occurrence are typical of a Controlled Flight into Terrain (CFIT) accident. CFIT occurrences are those in which an aircraft, under the control of the crew, is flown into terrain (or water) with no prior awareness on the part of the crew of the impending disaster. The Board notes with concern that, over the 11-year period from 01 January 1984 to 31 December 1994, 70 commercially operated aircraft (not including those conducting low-level special operations) were involved in CFIT accidents. In view of the frequency and severity of such accidents, the Board is currently conducting a study of CFIT accidents to identify related systemic deficiencies.

The International Civil Aviation Organization (ICAO) has recently released a task force report on CFIT prevention which recommends many changes to help reduce CFIT accidents. One of the recommendations is to eliminate 3-pointer altimeters, such as the altimeter involved in this accident.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson John W. Stants, and members Zita Brunet and Hugh MacNeil, authorized the release of this report on 01 August 1995.

Appendix A - Glossary

agl	above ground level
AIP	Aeronautical Information Publication
asl	above sea level
ATPL	airline transport pilot licence
CFIT	controlled flight into terrain
CPL	commercial pilot licence
CRM	cockpit resource management
DME	distance measuring equipment
FSS	Flight Service Station
GPS	global positioning system
GPWS	ground proximity warning system
hr	hour(s)
ICAO	International Civil Aviation Organization
in. Hg	inches of mercury
lb	pound(s)
LL	low lead
N/A	not available
NDB	non-directional beacon
nm	nautical mile(s)
NST	Newfoundland standard time
PDM	pilot decision making
PPC	pilot proficiency check
SOP	standard operating procedure
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VFR	visual flight rules

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