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

AVIATION OCCURRENCE REPORT

VFR INTO IMC - CONTROLLED FLIGHT INTO TERRAIN

WESTERN STRAITS AIR
DE HAVILLAND DHC-3 (TURBINE) OTTER C-FEBX
CAMPBELL RIVER, BRITISH COLUMBIA 7 nm NW
27 SEPTEMBER 1995

REPORT NUMBER A95H0012

Canada

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- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
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Aviation Occurrence Report

VFR into IMC - Controlled Flight into Terrain

Western Straits Air
de Havilland DHC-3 (Turbine) Otter C-FEBX
Campbell River, British Columbia 7 nm NW
27 September 1995

Report Number A95H0012

Synopsis

The aircraft was en route from Triumph Bay (40 nm south of Kitimat), British Columbia, to the Campbell River Airport. Approaching Campbell River, the pilot requested and received a special visual flight rules (SVFR) clearance to enter the Campbell River control zone. While on an intercept heading for the final approach and in straight-and-level flight, the aircraft crashed into the side of a mountain. The pilot and seven of the passengers received fatal injuries; the other two passengers received serious injuries.

The Board determined that the pilot progressively lost situational awareness while attempting to navigate in conditions of low visibility or in cloud and was unaware of the rapidly rising terrain in his flight path. Contributing to this accident were the existing visual flight regulations and the prevailing industry attitudes and practices which did not provide adequate safety margins. Contributing to the severity of the injuries was the detachment of the passenger seats at impact.

Ce rapport est également disponible en français.

Table of Contents

Page

1.0 Factual Information

1.1 History of the Flight

The single-engine turbine Otter on amphibious floats departed Triumph Bay, British Columbia, at 1634 Pacific daylight saving time (PDT[1]) with one pilot and nine passengers on board for a visual flight rules (VFR[2]) flight to Campbell River. At 19:01:59 the pilot called Campbell River Flight Service Station (FSS) and reported that he was seven nautical miles (nm) northwest of the airport, inbound for Campbell River. Radar data from Comox indicate that, when this call was made, the aircraft was actually 11 nm northwest of Campbell River, just south of the Narrows (see map, Appendix A). At 19:02:40, the pilot was given the 1900 PDT Campbell River weather observation, which was as follows: ceiling 300 feet overcast and visibility two miles in light rain and fog.

The pilot requested a special VFR (SVFR) clearance to enter the Campbell River control zone. Clearance for SVFR was delayed by Comox air traffic control (ATC) until an instrument flight rules (IFR) aircraft on approach to Campbell River had landed. At 19:03:54, the IFR aircraft reported breaking clouds at 900 feet above sea level (asl), which would be approximately 550 feet above ground level, on the ILS approach to runway 11 at Campbell River (airport elevation is 346 feet). This information was acknowledged by the turbine Otter pilot. The IFR aircraft landed at 1904, and the turbine Otter was issued an SVFR clearance at 19:04:45. Radar data indicate that, at that time, the aircraft was about one mile northwest of Tyee Spit, a frequently used, alternate landing site (water) for company aircraft when weather conditions preclude landing at Campbell River airport.

Radar data indicate that, at 1906, after passing by Tyee Spit, the aircraft turned southbound and flew directly toward the airport. At about 2 1/2 miles from the airport, at 19:07:40, the aircraft turned right to a heading of approximately 310° magnetic and flew in that general direction for about two minutes. The aircraft was on a track that was approximately parallel to the extended runway centre line, tracking outbound from the airport with the localizer and the Campbell River (YBL) non-directional beacon (NDB) to the left. The aircraft passed abeam the YBL NDB, which serves as the final approach fix (FAF) for the ILS approach to runway 11, and continued outbound.

1 All times are PDT (Coordinated Universal Time [UTC] minus seven hours) unless otherwise stated.

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

At 19:09:40, at about three miles outside the beacon, the aircraft turned left to a southerly heading toward the localizer and the YBL NDB. At 19:10:08, the pilot radioed that he was seven miles northwest; this was the last transmission received from the aircraft. At 19:10:25, radar contact was lost.

The aircraft crashed into the northwest side of a 1,047-foot mountain at about the 860-foot level, in straight-and-level flight on a heading of 183˚ magnetic. The pilot and seven of the passengers received fatal injuries. The two remaining passengers received serious injuries. The accident occurred at 1910 PDT during the hours of official daylight, at latitude 50˚01'N, longitude 125˚22'W. Official sunset in Campbell River was at 1908, and night was at 1940 PDT.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	1	7	-	8
Serious	-	2	-	2
Minor/None	-	-	-	-
Total	1	9	-	10

1.3 Damage to Aircraft

The aircraft struck the mountain in an area of heavily forested upslope. It shed the right wing and tail section while passing through the trees, then struck an embankment beside an access road that leads to the top of the mountain. The aircraft was destroyed during the impact sequence.

1.4 Other Damage

Several trees were broken. There was no other environmental damage.

1.5 Personnel Information

	Captain
Age	37
Pilot Licence	ATPL
Medical Expiry Date	09 Nov 1995
Total Flying Hours	9,002
Hours on Type	1,251
Hours Last 90 Days	234
Hours on Type Last 90 Days	58
Hours on Duty Prior to Occurrence	12
Hours Off Duty Prior to Work Period	72

The pilot was certified and qualified for the flight in accordance with existing regulations. He was flying the aircraft from the left seat. The right front seat was occupied by a passenger. The pilot had a valid Category 1 medical at the time of the accident, and records indicate that he had renewed his aviation medical regularly since his first aviation medical in 1976. His only restriction was that "glasses must be worn."

The pilot had flown in the Campbell River area for most of his career. He had been employed by Western Straits Air since 1988, and had flown several types of light, single- and twin-engine aircraft for the company. He began flying the turbine Otter in 1989 and was considered to be experienced on the aircraft.

He held a valid instrument rating. Most recently, his primary job was to fly as captain on the company Beechcraft King Air 200 on scheduled IFR flights between Campbell River and Vancouver. He was also the company's chief pilot, and had previously held the positions of company safety officer and operations manager.

The pilot had previously discussed with the company's current operations manager the option of doing an IFR approach into Campbell River with the turbine Otter if weather conditions would not allow VFR or SVFR flight. Although IFR flight was not authorized under the company's operating certificate for this type of passenger-carrying operation, the pilot felt that the aircraft was adequately equipped to climb to a safe altitude and follow radar vectors provided by the Comox ATC unit, to conduct an IFR approach. There are indications that the pilot had previously conducted such IFR arrivals in the turbine Otter.

The pilot's training records indicate a history of satisfactory performance on proficiency checks. All required currency training had been completed. He was considered a safe, careful, and competent pilot by both his employer and his colleagues.

1.6 Aircraft Information

Manufacturer	de Havilland Aircraft of Canada Limited
Type and Model	de Havilland DHC-3 Otter
Year of Manufacture	19 February 1954
Serial Number	38
Certificate of Airworthiness (Flight Permit)	12 June 1989
Total Airframe Time	16,428.5 hours
Engine Type (number of)	P&W PT6A-135A (1)
Propeller/Rotor Type (number of)	Hartzell HC-B3TN-3DY (1)
Maximum Allowable Take-off Weight	8,000 lb
Recommended Fuel Type(s)	Jet A/Jet A-1
Fuel Type Used	Jet A-1

1.6.1 General

The original DHC-3 Otter aircraft is an all-metal, high-wing monoplane designed to carry passengers and/or cargo and powered by a Pratt & Whitney, 9-cylinder, radial, air-cooled engine fitted with a Hamilton Standard propeller. The occurrence aircraft was equipped with a Pratt & Whitney PT6 turbine engine and a Hartzell propeller, which were installed in 1989 as a modification. At the time of the accident, the aircraft was equipped with Bristol-Edo amphibious floats.

1.6.2 Flight Instruments and Radios

The aircraft was equipped with standard flight instruments and the following communication and navigation equipment: dual very-high-frequency (VHF) communication radios; dual VHF omni-directional range (VOR)/instrument-landing-system (ILS) receivers; a single automatic direction finder (ADF) receiver; dual transponders; and a Loran C receiver. The aircraft was not equipped with distance measuring equipment (DME). It was not equipped with a radar altimeter or a ground proximity warning system, nor was either required by regulation. The aircraft maintenance records and post-accident testing both indicate that the flight instruments, communication radios, and navigation equipment were serviceable at the time of the occurrence. Details are available in TSB Engineering

Branch Report LP 143/95.

1.6.3 Weight and Balance

The aircraft load-control/manifest form was retrieved from the aircraft wreckage. The form recorded a take-off weight from Triumph Bay of 7,999 pounds, one pound below the maximum gross take-off weight of 8,000 pounds. There was no indication that a centre of gravity (C of G) position was calculated for the flight.

Post-accident calculations using actual passenger and baggage weights (see Appendix B) indicate that the weight of the aircraft exceeded the maximum allowable gross weight by approximately 900 pounds at take-off from Triumph Bay, and by approximately 50 pounds at impact. Also, the actual C of G exceeded the aft limit by 3.29 inches at take-off from Triumph Bay, and by 2.71 inches at impact.

Errors in the load-control calculations were the result of the following: using lower than standard weights for male occupants (using 172 pounds instead of 182 pounds); not including baggage in the calculations (395 pounds of baggage was recovered from the wreckage); and underestimating the fuel weight by 323 pounds.

A review of the aircraft journey log entries indicates there were other flights for which the duration and the passenger and fuel loads were similar to those of the accident flight. Since the company load control practices were the same, it is likely that the aircraft weight and balance on those flights were also in excess of the approved limits for the aircraft.

There was no indication that company management and operational personnel were aware of the extent to which the turbine Otter aircraft was operated above its maximum approved gross weight; however, there is also no indication that the appropriate steps were taken to determine the actual aircraft weights.

1.6.4 Aircraft Engine

The engine in the accident aircraft had accumulated 1,342.8 hours since undergoing a hot section inspection (HSI). During the accumulation of these hours, the company had stopped a previously used Engine Condition Trend Monitoring Program (ECTM) designed to lengthen operating times between HSIs; therefore, the engine should have undergone an HSI at 1,250 hours. At the time of the accident, the aircraft's engine was 92.8 hours over the 1,250 hours of operating time allowed between hot section inspections. This was not found to be contributory to the accident. Details are available in Engineering Branch Report LP 164/95.

1.6.5 Maintenance Records

There were no recorded current or deferred defects on the occurrence aircraft at the time of the accident. Company maintenance records indicate that, at the time of the occurrence, along with the overdue HSI, required inspections on the altimeters, pitot-static system, and the transponders were overdue. These overdue inspections were not a factor in this accident. Details are available in Engineering Report LP 164/95.

1.7 Meteorological Information

The pilot was known to review the available weather information before each flight. The forecast for Campbell River, issued at 0803 PDT, and valid from 27/1500Z (0800 PDT) to 28/0300Z (2000 PDT), was included in the weather package faxed to the company on the morning of the accident. The forecast was as follows:

> 500 feet scattered, ceiling 1,500 feet broken, 4,000 feet overcast, visibility more than 6 miles, occasional ceiling 500 feet broken, 1,200 feet overcast, visibility 5 miles in light rainshowers and fog. By 2100Z (1400 PDT) 1,500 feet scattered, ceiling 5,000 feet broken, visibility more than 6 miles, occasional ceiling 1,500 feet overcast, visibility more than 6 miles in light rainshowers. Next forecast by 2100Z (1400 PDT).

Light rime icing was forecast to occur in cloud above the freezing level, which was located at 8,000 feet.

No other weather forecast was requested by, or issued to, either the pilot or the company prior to the occurrence.

At 1405 PDT, one hour and ten minutes after the turbine Otter departed Campbell River for the round-trip flight to Triumph Bay, a new weather forecast was issued, valid from 27/2100Z (1400 PDT) to 28/0500Z (2200 PDT). The forecast was as follows:

> 500 feet scattered, ceiling 1,500 feet broken, 4,000 feet overcast, visibility more than 6 miles, occasional ceiling 500 feet broken, 1,200 feet overcast, visibility 3 miles in light rainshowers and fog. By 0000Z (1700 PDT) 1,500 feet scattered, ceiling 5,000 feet broken, visibility more than 6 miles, occasional ceiling 1,500 feet broken, 5,000 feet overcast, visibility more than 6 miles in moderate rainshowers. Next forecast by 0300Z (2000 PDT).

An amended forecast was issued at 1614 PDT, valid from 27/2300Z (1600 PDT) to 28/0500Z (2200 PDT), as follows:

> 500 feet scattered, ceiling 1,500 feet broken, 4,000 feet overcast, visibility more than 6 miles, occasional ceiling 500 feet broken, 1,200 feet overcast, visibility 3 miles in light rainshowers and fog. By 0400Z (2100 PDT) 1,500 feet scattered, ceiling 5,000 feet broken, visibility more than 6 miles, occasional ceiling 1,500 feet broken, 5,000 feet overcast, visibility more than 6 miles in light rainshowers.

An amended forecast was issued at 1724 PDT, valid from 28/0000Z (1700 PDT) to 0500Z (2200 PDT), as follows:

> 500 feet scattered, 1,500 feet broken, 4,000 feet overcast, visibility more than 6 miles, occasional ceiling 300 feet broken, 1,200 feet overcast, visibility 2 miles in light rainshowers and fog. By 0400Z (2100 PDT) 1,500 feet scattered, 5,000 feet broken, visibility more than 6 miles, occasional ceiling 1,500 feet broken, 5,000 feet overcast, visibility more than 6 miles in light rainshowers. Next forecast by 0300Z (2000 PDT).

Ceilometer readings and observed weather conditions at the Campbell River airport indicate that, throughout the day of the accident, the ceiling varied between 300 feet and 500 feet above ground level (agl) broken to overcast, and that the visibility varied between 2 and 4 statute miles (sm) in light rain and fog.

The pilot received several weather reports for Campbell River during the flight from Triumph Bay to Campbell River, as described below.

At 1727 PDT, 1 hour 43 minutes before the accident, he received the 1700 PDT actual weather as follows: measured 300 feet broken, 500 feet overcast, visibility 2 1/2 miles in light rain showers and fog.

At 1812 PDT, 58 minutes before the accident, the pilot received the 1800 PDT actual weather as follows: measured 400 feet broken, 600 feet overcast, visibility 2 1/2 miles in light rain showers and fog.

At 1902 PDT, 8 minutes before the accident, he received the 1900 PDT actual weather as follows: measured 300 feet overcast, visibility 2 miles in light rain and fog.

At 1904 PDT, 6 minutes before the accident, he overheard and acknowledged the crew of another aircraft, who reported breaking clouds at 900 feet asl, 550 feet agl, on approach to runway 11 in Campbell River.

One survivor reported that there was heavy fog in the area of the crash site.

About 30 minutes after the accident, the pilot of a fixed-wing, search and rescue (SAR) aircraft noted localized low cloud in the accident area. The pilot reported that, on approach to Campbell River, the aircraft broke out of clouds at 200 to 300 feet agl, and that the visibility was 1/2 mile or less. A SAR helicopter that departed from Comox about one hour after the crash could not get to the Campbell River airport because of low stratus cloud and fog. About one hour after that, as the weather in Campbell River lifted and an aerial search could begin, the weather was observed to be zero/zero in the area of the emergency locator transmitter (ELT) signal.

1.8 Aids to Navigation

The Campbell River airport is equipped with an NDB located 4.3 nm from the runway threshold along the final straight-in approach path to runway 11, an ILS that serves runway 11, and a DME (the accident aircraft did not have a DME receiver). There were no reports of any abnormalities with these navigation/approach aids.

1.9 Communications

A review of the taped transmissions between the aircraft and ground-based facilities revealed that all communications were routine and normal, with no abnormalities.

1.10 Aerodrome Information

The Campbell River airport (CYBL) is located 4.5 miles south of the city and is operated by the District of Campbell River. It is serviced by a single asphalt runway, 5,000 feet long and 150 feet wide. The runway orientation is 11/29 (113 degrees/293 degrees). Airport elevation is 346 feet asl.

The airport is located in controlled airspace and is surrounded by a control zone of 5 nm radius extending upward to 3,300 feet asl. There is no control tower; an FSS provides advisory information on the mandatory frequency (MF). For flights under IFR and SVFR, authorization from the Comox terminal control unit is relayed by the FSS on the MF.

Pilots familiar with the area indicated that they were not aware of the actual height of the mountain that the accident aircraft had collided with. Although the top of the mountain is 1,047 feet, it is not high enough for it to be required to be marked as a spot height on an instrument approach chart. Pilots conducting instrument approaches would not necessarily be aware of the mountain as their attention would be concentrated on navigational instruments and not on outside visual cues. In addition, the two towers at the top of the mountain are not marked on the VFR Navigation Chart (VNC) because they are less than 300 feet agl. Normal VFR flights are not conducted in the area of the mountain. During the investigation, pilots familiar with the area commented that they had not previously placed any significance on the hazard that the mountain might impose on VFR flight. It is possible that the accident pilot also would not have been aware of the height of the mountain and the significance of the hazard.

1.11 *Flight Recorders*

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

1.12 *Wreckage and Impact Information*

1.12.1 *Site Details*

Examination of the accident site indicates that the aircraft was in straight-and-level flight on a heading of 183° magnetic when it flew into a tree-covered, 34-degree upslope at the 860-foot level of a 1,047-foot high mountain.

The length of the wreckage trail was approximately 183 feet. The initial impact was with the top of a cedar tree, which broke off at a point 60 feet above the ground. This impact tore away the left elevator. As the aircraft continued into the trees, the right wing came off and the aircraft rolled to the right. The horizontal stabilizer struck a tree, and the remainder of the tail section was torn from the fuselage. The drag from the float pieces still attached to the fuselage turned the fuselage to the left and it struck an embankment and a large tree stump on the side of an access road. The main force of the impact was sustained by the right side of the fuselage structure.

At the time of impact, the flaps were retracted, and the wheels in the amphibious floats were in the down-and-locked position.

1.12.2 *Wreckage Examination and Testing*

After an initial examination at the site, several aircraft components were transported to the TSB Engineering Branch and to other facilities for further inspection and testing. Components inspected included the following: cockpit and panel light bulbs, flight and engine instruments, communication and navigation radios, seats and seat-belts/shoulder harnesses, and the propeller. The engine was shipped to the manufacturer's facility where it was examined under the direction of a TSB investigator. The generator was forwarded to the manufacturer for testing under the direction of the United States of America Federal Aviation Administration (FAA). The aircraft digital fuel-management system was examined at the TSB Engineering Branch and then forwarded to the manufacturer, where the non-volatile memory chips were examined.

There were no pre-impact material failures or component malfunctions found that could have contributed to the cause of the accident.

1.12.3 *Communication and Navigation Radio Settings*

The communication and navigation radios were set as follows: number 1 radio set to 123.30 Unicom; number 2 radio set to 122.50 Campbell River mandatory frequency; number 1 VOR/ILS receiver to 112.05 (this frequency is not allotted to any radio facility); number 2 VOR/ILS to 109.1, the ILS frequency for runway 11; and Loran C set to navigate direct to the YBL NDB (which is also the final approach fix for the approach to runway 11). The ADF active frequency was 400, the Comox NDB, and the standby frequency was 203, the YBL NDB. Switching between the two frequencies is achieved by depressing a spring-loaded, push-button switch on the front panel of the ADF. The position of this switch made it vulnerable to being moved during the accident sequence.

1.13 *Medical Information*

An autopsy was conducted on the pilot, and toxicological samples were examined. There was no indication that incapacitation or physiological factors affected the pilot's performance.

1.14 *Fire*

It was reported that small, post-crash fires were extinguished by rescue personnel; however, there was no other indication of fire at the accident site either before or after the occurrence.

1.15 *Survival Aspects*

1.15.1 *Search and Rescue*

When the aircraft failed to arrive at Campbell River airport, the FSS operator immediately informed the company, and, within 10 minutes of the accident, an emergency response had been initiated. A Search and Rescue (SAR) Buffalo aircraft on a training flight in the area was informed of the overdue aircraft by the FSS; the SAR aircraft had already picked up an ELT signal (the ELT functioned and was instrumental in confirming the status of the overdue aircraft and locating its position). Weather conditions precluded a visual aerial search.

About one hour after the crash, a SAR Labrador helicopter took off from Comox. Low ceilings and fog forced the helicopter to land at the Campbell River hospital, where one search and rescue technician from the helicopter joined local police for a land search. The air search resumed at 2310, and a steady ELT signal was picked up at 2320. Using flood lights, searchers located the aircraft in a wooded area, and at 2355 the site was reached by the ground search team.

One survivor was found wandering outside the aircraft and was evacuated by ambulance. The second survivor was extricated from the wreckage and flown to hospital by the SAR helicopter.

1.15.2 *Impact Forces*

An estimation of crash impact loads was completed. Details are available in TSB Engineering Branch Report LP 146/95.

It was concluded that the aircraft did not lose much speed as it crashed through the trees, and that most of the crash impact force experienced by the occupants was lateral, to the right, as the aircraft struck the embankment. The total load factor was determined to be over 14 g but under 22 g. The lateral force caused the left-side seats to break free from the aircraft structure, allowing the left-side occupants to be thrown to the right. The right-side occupants were then subjected to impact forces from the aircraft striking the embankment, and the impact by the left-side occupants.

In addition to the pilot and co-pilot seats, the cabin seating consisted of two rows of seats, one on each side of the cabin, separated by a centre aisle. The left-side row consisted of four seats, with a double-width cargo door located between the third and fourth seats. The right-side row consisted of five seats, with a single main cabin entry door located between the fourth and fifth seats. One survivor, a female, was seated in the most rearward seat on the right side, immediately aft of the main cabin door. She was apparently thrown free of the aircraft during the impact sequence. The second survivor, a male, was seated on the left side, immediately behind the bulkhead separating the cockpit from the cabin. He was found in the wreckage lying prone next to the bulkhead. Neither of the survivors was subjected to crushing injuries. All other occupants died from crushing injuries and multiple trauma.

1.15.3 Certification Requirements for Seats

The basis of approval for this aircraft, according to Transport Canada Type Approval Data Sheet A-27, is the United States Civil Air Regulation (CAR) Part 3 as amended to 01 November 1949. That regulation requires that aircraft seats be able to withstand the following crash inertia load factors: forward 9.0 g, upward 3.0 g, sideward 1.5 g. In this standard, the structural requirement is met by either structural analysis alone, a combination of structural analysis and static load tests, or static load tests alone.

Although the standard for inertia load factors has not changed, current occupant protection standards are significantly more effective because the static load testing formerly used to verify compliance has been replaced by dynamic testing. Aircraft are required to meet the design standards in force at the time of the conception of the aircraft design. Subsequent revisions to standards are not made retroactive.

1.15.4 Seats/Seat-belts/Shoulder Harnesses

Both of the cockpit seats remained attached to the fuselage, and neither of the lap belts had failed. The pilot was not wearing the available shoulder harness. The front-seat passenger was wearing the available shoulder harness; however, the harness webbing had failed in overload. The overload failure of the front-seat passenger's shoulder harness is attributed to a combination of the occupant's crash inertia and the force from the pilot as he was thrown to the right by impact forces.

All passenger seats were equipped with lap belts that were attached to the seats, and all the passengers' lap belts were fastened. None of the belts failed because of overload of the webbing. All of the left-side passenger seats that were occupied were detached from the fuselage as a result of the impact. The left-side passenger seats were torn from their side-fuselage attach points, the seat backs were torn free, and the floor attachments were popped out of place. On the right side, several side-fuselage attach points were still in place; however, the seat backs were torn free, the floor attach points were popped out of place, and the seats were badly deformed.

1.16 Organizational and Management Information

1.16.1 Description of the Company

Western Straits Air was operating under a valid Transport Canada operating certificate, first issued in March 1986 and last amended in September 1994. The company is approved for domestic and non-scheduled international commercial air services and operates five aircraft, including two turbine Otters, from its main base in Campbell River. The company management structure is designed to comply with Transport Canada requirements and is typical of other such operators who, under the president of the company, employ an operations manager, director of maintenance, chief pilot, chief engineer, and quality manager.

Company management is required by Transport Canada to put in place procedures to ensure compliance with the conditions of the company's operating certificate, and to ensure that company aircraft are operated and maintained in accordance with all approved manuals.

The degree of company supervision of the operations and maintenance functions at Western Straits Air was found to be typical of other such companies offering similar services.

1.16.2 Transport Canada Audits

The company had been audited by Transport Canada on a regular basis since the initial certification audit in 1986. The most recent operational audits, conducted in July 1993 and January 1995, were deemed to be satisfactory.

The latest Transport Canada maintenance audit, conducted in August 1994, and three base inspections did not discover that the company had stopped using its approved Engine Condition Trend Monitoring Program (ECTM). Transport Canada does not have in place a training program to ensure that all inspectors who are tasked with conducting such inspections are formally trained in ECTM.

1.17 Additional Information

1.17.1 Weather and Minimum Altitude Regulations

For the flight from Triumph Bay to Campbell River, while the aircraft was outside the Campbell River control zone and in uncontrolled airspace, the ceiling and visibility requirements to maintain VFR would have been clear of cloud with a minimum of two miles visibility. Given that the flight could be conducted over non-populous areas or over open water, there would be no altitude restriction mandated by the minimum altitude regulations; however, a distance of 500 feet would still have to be maintained from any person, vessel, vehicle, or structure. In summary, the flight would have been operating in accordance with regulations if operated clear of cloud with a minimum of two miles visibility.

VFR weather limits in the Campbell River control zone were a minimum ceiling of 1,000 feet agl (in order for the aircraft to be able to maintain a distance of 500 feet vertically from both the cloud base and the surface), and a minimum visibility of three miles. The weather at Campbell River was reported as ceiling 300 feet overcast, visibility two miles. The pilot requested, and was granted, SVFR to enter the control zone for landing.

SVFR restrictions applicable for flight within the Campbell River control zone would have been as follows: weather - flight and ground visibility of not less than one mile and clear of cloud; and minimum altitude - not less than 1,000 feet if over (within 2,000 feet of) a "built up area of any city, town or other settlement or over any open air assembly," or not less than 500 feet unless over a non-populous area or over open water. Prevailing weather conditions were above the minimum permissible to conduct flight in accordance with SVFR authorization; however, the weather conditions would have precluded the pilot from complying with the minimum altitude restrictions applicable to the track flown.

1.17.2 TSB Safety Study

The TSB released *Report of a Safety Study on VFR Flight Into Adverse Weather* (No. 90-SP002) in 1990. In this safety study, 333 accidents involving VFR flight into instrument meteorological conditions (IMC) in Canada were studied. Approximately 35% of the accidents involved aircraft engaged in commercial operations.

The safety study raised many concerns with respect to VFR commercial operations, with particular emphasis on VFR weather minima, SVFR, industry practices, and pilot decision making. The safety study concluded that accidents involving continued VFR into IMC account for a disproportionate number of fatalities each year, and that the causes and contributing factors to these accidents have recurring themes.

The recommendations in the safety study included the following:

> The Department of Transport revise the safety standards for commercial operations to include requirements designed to reduce the probability and seriousness of VFR-into-IMC accidents.
>
> (TSB A90-82)

> The Department of Transport increase the minimum flight visibility for VFR flight in all designated Mountainous Regions to two miles.
>
> (TSB A90-67)

> The Department of Transport increase the VFR weather minima for fixed-wing commercial operations in uncontrolled airspace.
>
> (TSB A90-66)

> The Department of Transport reconsider the decision to reduce SVFR weather minima to visibilities of one mile.
>
> (TSB A90-68)

The Department of Transport's response to recommendation TSB A90-82 indicated that no action would be taken and stated that the Department was continually reviewing and taking action to improve safety.

Recommendation TSB A90-67 was adopted and the limits were changed to two miles.

The Department of Transport passed recommendations TSB A90-66 and TSB A90-68 to a VFR Working Group for consideration. Weather limits in uncontrolled airspace were increased; however, operators may request waivers which would effectively return the VFR limits to those which were in effect at the time of this accident. There were no changes to the SVFR weather limits. It is important to note that, on the sliding scale of ceiling and visibility limits for SVFR in effect before 1990, SVFR would not have been approved for the accident flight.

1.17.3 Influence on Pilot Actions

Pilots tend to be greatly influenced by their perception of the prevailing attitudes and practices of other pilots and companies in the area where they work. These attitudes and practices can be strong determinants in the choices that they make. Discussions with people in the Campbell River aviation community indicate that it is common practice for pilots to attempt to find their way to the airport in bad weather by descending to low altitudes to "take a look" and see if there is a way to get to the airport. This practice is not unique to the Campbell River area, but is common within the aviation community. The accident pilot was experienced in the area, and reportedly performed such manoeuvres successfully on many occasions. There was no indication that company management exerted pressure on pilots to complete flights into Campbell River airport in marginal weather.

The more times people do something successfully, the more they tend to discount the risks involved, and the more likely they are to believe that, although the practice may have inherent risks in a general sense, nothing bad will happen to them. This can lead to a level of comfort where they are likely to further reduce the margin of safety.

1.17.4 Situational Awareness and Information Processing

Situational awareness consists of "all the knowledge that is accessible and can be integrated into a coherent picture, when required, to assess and cope with a situation"[3]. Pilots must maintain situational awareness in order to make sound judgements and decisions. Situational awareness develops as the pilot perceives the situational elements such as weather, clearances, aircraft instrumentation, etc., integrates the information by using experience and knowledge, and projects the information into the future to make or modify plans. The development and maintenance of accurate situational awareness is progressively impaired by inadequate information, or inaccurate interpretation of the available information, or both.

1.17.5 Canadian Accident Information

A controlled flight into terrain (CFIT) accident can be defined as an accident 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 TSB accident database shows that, between 01 January 1984 and 31 December 1994, 70 commercially operated aircraft not conducting low-level specialty operations had a CFIT accident. For 95% of CFIT accidents where VFR flight was intended, weather conditions were below those required for VFR. The data also indicate that in 97% of CFIT accidents, the crew(s) either continued descending below a known safe altitude, or were not considering a safe altitude at which to fly. Also, none of the aircraft involved were equipped with a ground proximity warning system (GPWS), and 91% were not equipped with a serviceable radio altimeter.

[3] N.B. Sarter and D.D. Woods, "Situation Awareness: A critical but ill defined phenomenon," *The International Journal of Aviation Psychology* 1.1 (1991): 45-57.

This occurrence is typical of a CFIT accident, the most common element of which is that the pilot has lost situational awareness, and is unaware of the imminent danger. Information from TSB data, including the 1990 safety study of VFR flight into adverse weather, shows that this accident fits the profile of a typical weather-related accident for a VFR commercial operator.

2.0 Analysis

2.1 Introduction

The accident aircraft was adequately equipped and maintained for VFR flight, and there were no pre-impact mechanical failures. There is nothing to suggest that the aircraft load was a contributing factor, and there was nothing to indicate loss of control before the aircraft struck the trees in straight-and-level flight.

2.2 Seats/Seat-belts (Survivability)

No conclusion could be made as to whether there might have been additional survivors had the seats been more securely attached to the airframe. However, there is no doubt that additional injuries occurred as a result of the seats breaking free.

Injuries to the pilot and the front-seat passenger would have been lessened had the pilot been wearing the available shoulder harness.

2.3 Regulations for VFR/SVFR

The 1990 TSB safety study found that CFIT accidents involving VFR aircraft were linked to flight in marginal weather conditions, and that regulations provided inadequate safety margins. At that time, the Board was concerned that the amendment to Air Navigation Order (ANO) Series V, No. 1 (June 1990) that eliminated the sliding scale authorizing SVFR would lead to greater use of SVFR in weather conditions "worse than those which permitted the studied accident flights to occur." Accordingly, the Board recommended that:

> The Department of Transport reconsider the decision to reduce SVFR weather minima to visibilities of one mile.
>
> (TSB A90-68)

Transport Canada responded that this recommendation would be addressed by the VFR working group. To date, the SVFR weather minima remain unchanged. It was apparent during the investigation of this accident that, in fact, the use of SVFR in such weather conditions had become an accepted norm in the Campbell River control zone. It is important to note that, prior to June 1990, an SVFR clearance would not have been approved for the accident flight because of the reported weather conditions and the pilot would not have been able to continue with his plan to land at the Campbell River airport.

2.4 Decision to Fly to the Airport

As the aircraft approached Campbell River, the pilot had two options to continue visual flight: to attempt to land at the airport, or to land at Tyee Spit. When he overflew Tyee Spit, the pilot was aware of the official weather reports from the airport; however, he was also aware of the fact that another aircraft on approach to runway 11 had reported a better ceiling than the official report.

The pilot's decision to fly to the airport is consistent with the accepted industry and local practice of taking a look at the conditions, and with the pilot's own history of operating in such conditions. Once he obtained SVFR, he could attempt the airport landing without violating any weather limits. Given the flight route and altitude flown, it appears that he either ignored, or was not aware of, the minimum altitude order which would have required him to maintain a minimum of 500 feet agl over populous areas.

After the pilot turned back from his initial attempt to fly directly to the airport, the track of the aircraft, as recorded by radar, is consistent with an attempt to proceed outbound parallel to the ILS for runway 11, and then turn onto a heading to intercept the localizer inbound in the area of the Campbell River NDB. This hypothesis is supported by the settings on the navigation equipment.

Although the pilot may have considered the option of conducting an instrument approach at that point, there is no indication that he had attempted to do so. The pilot may have been influenced by either his assessment of the weather conditions as being still suitable for SVFR flight, or a possible reluctance to violate the company's operating certificate which restricted operation of the aircraft to VFR.

The aircraft was in straight-and-level flight at impact. This suggests either that flight visibility was such that the mountain was totally obscured, or that the aircraft had entered cloud; this also suggests that the pilot had lost situational awareness and did not see the rising terrain until it was too late to avoid a collision.

2.5 Summary

Had the flight been completed successfully, it would have been viewed as just another normal flight. The pilot's decision to try to get to the airport in marginal weather conditions is consistent with both his past practice and the industry-accepted norms for this type of operation, and led to the progressive erosion of his situational awareness. It is apparent that he was attempting to use visual flight, supplemented by IFR navigational methods. In such marginal weather conditions, this combination does not provide the level of protection normally associated with either flight regime, in that pilots are restricted in their ability to navigate visually, and are not protected by the minimum obstruction clearance altitude restrictions imposed by IFR navigation. Accident statistics consistently show that VFR flight in marginal weather imposes a significant risk. More stringent regulations, as previously recommended by the Board, might have led the pilot to alter his plan to fly to the airport.

3.0 Conclusions

3.1 Findings

1. The pilot was certified and qualified in accordance with existing regulations, and there was no indication that incapacitation or physiological or psychological factors affected his performance.

2. There were no indications of any pre-impact failures or aircraft malfunctions that could have contributed to the occurrence.

3. For the entire flight, the aircraft was operating outside its certified weight and balance envelope. This was not found to be contributory to the accident.

4. Review of the aircraft journey log entries indicates there were other flights where the aircraft weight and balance were also in excess of the approved limits for the aircraft.

5. At the time of the accident, the aircraft's engine was 92.8 hours over the 1,250 hours of operating time allowed between hot section inspections. This was not found to be contributory to the accident.

6. Although the weight and balance and engine discrepancies were not found to be contributory, they indicate inadequate management supervision in these areas.

7. The degree of company supervision of the operations and maintenance functions at Western Straits Air was found to be typical of other such companies offering similar services.

8. DHC-3 Otter passenger seats do not meet current design standards, nor is this required by regulation.

9. The pilot was not wearing the available shoulder harness and was thrown into the front-seat passenger on impact. This contributed to the injuries suffered by both the pilot and the passenger.

10. Failure of the passenger seats to remain attached to the airframe contributed to the extent of the injuries suffered by the occupants.

11. The continued flight into marginal weather conditions resulted in the progressive loss of the pilot's situational awareness and the collision with the terrain.

12. The pilot's decision to continue the flight into marginal weather conditions was probably influenced by the prevailing industry attitudes and practices regarding VFR and SVFR operations.

13. In the marginal weather of this occurrence, the pilot's use of visual flight procedures supplemented by IFR navigational methods did not provide the level of safety normally associated with either regime.

14. The regulations governing VFR and SVFR commercial operations at the time of this accident were the same as the regulations assessed in the 1990 TSB safety study as providing inadequate safety margins.

3.2 Causes

The pilot progressively lost situational awareness while attempting to navigate in conditions of low visibility or in cloud and was unaware of the rapidly rising terrain in his flight path. Contributing to this accident were the existing visual flight regulations and the prevailing industry attitudes and practices which did not provide adequate safety margins. Contributing to the severity of the injuries was the detachment of the passenger seats at impact.

4.0 *Safety Action*

4.1 *Action Taken*

4.1.1 *Seating and Restraint System*

Subsequent to this accident, the TSB issued a safety advisory to Transport Canada (TC) identifying a concern that seating and restraint systems of some aging aircraft do not provide adequate protection to passengers in the event of a crash or forced landing. Aircraft systems are being modernized to extend their useful lives for commercial passenger-carrying operations, but these upgrades seldom include the improved passenger safety provisions consistent with contemporary standards. Thus, the TSB suggested that TC take a more systems-oriented approach in approving such life-extension programs.

4.1.2 *Engine Condition Trend Monitoring*

During the investigation, it was established that the ECTM program, which formed part of the approved maintenance program for the turbine engine installation on C-FEBX, had not been used as per Transport Canada's approval. It was also determined that some of the TC airworthiness inspectors responsible for the Western Straits Air maintenance system were not trained in trend monitoring programs. The TSB subsequently advised TC of this issue and suggested that TC consider adding ECTM to the airworthiness inspectors' training curriculum.

4.2 *Action Required*

Air Regulations and Air Navigation Orders established under the *Aeronautics Act*, such as those governing VFR and SVFR flights, prescribe operating limits. Such limits are designed to provide operational flexibility, while ensuring minimum acceptable safety margins. Such regulations are influential elements in determining industry operational practices and in establishing the level of safety of the transportation system.

The Campbell River accident raises questions regarding the feasibility of VFR and SVFR flights in marginal weather conditions, considering pilots' limited capability to recognize deteriorating visibility, the adequacy of the margin of safety afforded by VFR and SVFR regulations, and the level of operators' awareness of the risks associated with commercial operations in marginal weather conditions.

4.2.1 *Visual Flight - Margin of Safety*

In its 1990 *Report of a Safety Study on VFR Flight into Adverse Weather* (90-SP002), the Board made several recommendations to the Department of Transport concerning visual flight rules. In recognition of the problems of safely maintaining visual references in mountainous terrain, the Department of Transport subsequently increased VFR visibility minima in designated mountainous areas from one mile to two miles.

At the time of this occurrence, the aircraft was operating under VFR in uncontrolled airspace within a designated mountainous area. To be in compliance with VFR, the aircraft was required to be flown with reference to the ground or water and remain clear of cloud; the pilot was required to stay within sight of the surface of the earth at all times, and was required to ensure a minimum flight visibility of two miles. Under SVFR in the Campbell River control zone, the same restrictions would apply except that the minimum flight visibility would be one mile. There are no minimum ceiling requirements for either SVFR flight or VFR flight in uncontrolled airspace below 1,000 feet agl.

The accident record continues to show that VFR CFIT accidents occur primarily when operations are being conducted in marginal weather and/or dark night conditions. Interviews with flight crew and operators obtained during this investigation indicate that it is common practice in the industry to continue flight operations at the minimum visibility requirements for VFR and SVFR. When operating in conditions that include low ceilings and visibilities, pilots often pick their way through the weather while trying to stay visual. Flight in marginal weather presents a high risk of inadvertent entry into conditions where visual reference is insufficient for the maintenance of aircraft control, terrain and traffic avoidance, and accurate navigation. There are substantial grounds for questioning a pilot's ability to safely complete flights under such conditions.

<u>Visual Depth Perception</u>. In perceiving both depth and distance, humans interpret several visual cues in such a way as to generate a three-dimensional image in the visual cortex of the brain:

a. <u>Linear Perspective</u> The distances between distant images appear to be less than those separating near images. For instance, railway tracks appear to converge in the distance. Knowing that the tracks remain a fixed distance apart, the convergence is interpreted as a distance cue.

b. <u>Clearness</u> In general, the more distant an object, the less clearly it is seen. Further, a mountain on a hazy day appears more distant than it would on a clear day.

c. <u>Interposition</u> When an object partially obstructs the view of another object, the first object appears nearer.

d. <u>Shadows</u> Humans are used to perceiving objects with light sources situated above them; this information is used to give objects a spatial orientation.

e. Gradients of Texture Generally, the texture of a scene appears finer and there is less detail as distance increases; conversely, foreground appears coarser and there is more perceptible detail.

f. Movement When the head moves, objects move in relation to oneself and to each other. Objects beyond the eyes' visual fixation point move in the same direction as the head. Objects nearer than the point of visual fixation appear to move in the direction opposite to the movement of the head. The amount of movement is less for distant objects than for near objects.

Assessing Distance in Marginal VFR. When visibility is poor, the cues to perceive distances of objects are diminished. Without these cues, consistent, accurate judgement of distance is improbable, even in a relative sense.

Humans tend to be poor judges of distance in absolute terms; they can best judge distance in relation to some fixed marker. Thus, trained weather observers use known distances from ground features to establish ground visibility. In the mountainous area of Vancouver Island, distance cues or markers are much less likely to be available. Reliably judging one mile of visibility from a moving aircraft is arguably a task beyond human capability.

Another factor that could detract from a pilot's ability to judge whether the one-mile visibility requirement is being met relates to the angle of flight visibility being considered. The primary requirement of visual flight is that the aircraft shall be flown with reference to the ground or water. When an obscuring phenomenon like fog is present, the reduction in visibility at low altitude can be much less looking downward than looking forward. The survivors of the Campbell River crash reported that they were able to see the ground in the Campbell River area; however, obstacle avoidance requires forward visibility, which was not available. A reasonably clear view of the ground in marginal conditions could lead a pilot to believe that the one-mile forward flight visibility requirement was being met. Clear downward visibility would likely be an influential cue to the pilot, even though not necessarily a reliable or accurate cue.

Aircraft flight control and navigation may be conducted exclusively by visual reference to cues outside the cockpit, by reference to aircraft instrumentation, or by varying combinations of external and internal references. In this accident, the pilot was apparently attempting to avoid terrain and navigate by using a combination of external references and aircraft instrumentation.

In Canada, air-taxi operations are often conducted fully or in part under visual flight rules. Over an eleven-year period (01 January 1984 to 31 December 1994), there were 70 accidents involving commercially operated aircraft not conducting low-level special operations, where the aircraft were flown into terrain, water, or obstacles, under control, while the crew had no awareness of the impending disaster. In over half of the occurrences, the crew was attempting to see the ground in order to fly visually, although the conditions apparently precluded visual flight. These 70 CFIT accidents involved pilots with the full range of experience, indicating that experience does not appear to be a factor in reliably coping with conditions of marginal visibility. Several recent commercial accidents (A95P0268, A95C0026, A95Q0104) in which VFR flights were attempted in flight conditions which did not allow the pilots to visually navigate and/or avoid collision with terrain illustrate that the same issues continue to be factors in this type of occurrence.

The Board understands that the present VFR and SVFR requirements are the result of years of evolution in committee proceedings; however, these committees seldom include representation from the scientific community, and therefore do not take into account the research available on such aspects as the human visual system and normal human information processing capabilities. Safe operations in VFR and SVFR conditions depend almost entirely on the pilot's ability to assess flight visibility and immediately recognize any deterioration. When flying in the minimum weather conditions allowed by VFR and SVFR, recognition of deteriorating visibility can be virtually impossible, particularly when combined with other factors such as high workload, variable weather conditions, poor light conditions, or limited outside visual cues. Therefore, the Board recommends that:

> The Department of Transport sponsor research to establish on a scientific basis the ability of pilots to assess distances, make appropriate decisions, and control aircraft without reference to aircraft instruments in the marginal visibility conditions of VFR and SVFR minima.

A96-09

Adequacy of Current Regulations. Under current regulations, the requirement to fly VFR is that the aircraft shall be flown with visual reference to the ground or water. The new Canadian Aviation Regulations state that the aircraft shall be operated with "visual reference to the surface." Neither regulation defines just what constitutes "visual reference to the surface"; nor is any rationale provided as to what a pilot is expected to do based solely on that visual reference. Nevertheless, it is the Board's understanding that the basic tenet of VFR flying in Canada is that the pilot be able to maintain control of the aircraft, avoid obstacles and other air traffic, and navigate solely through the observation of references external to the aircraft. Given that the 70 CFIT accidents involving commercially operated aircraft referred to above claimed 106 lives and left 23 persons seriously injured, the Board believes that the regulatory requirements for visual flights and the understanding and the application of these requirements by pilots (even experienced and instrument-rated pilots) are inadequate. The severe consequences and high probability of error in assessing flight visibility suggest that these regulations are particularly inappropriate in the context of commercial passenger-carrying operations. Therefore, in the light of the findings of the research recommended above, the Board recommends that:

> The Department of Transport evaluate the adequacy of the margin of safety afforded by

current VFR and SVFR regulations--particularly for commercial passenger-carrying operations.

A96-10

Application of Regulations. Regardless of the prescribed minima, the variability of flight visibility and the subjectivity in assessing it from a moving aircraft make enforcement of visibility requirements implausible in most circumstances. Apparent differences of opinion among pilots and operators as to the application of the prescribed minima further exacerbate the situation. Education and training seem to offer the most scope for practically implementing the visibility requirements. Yet, commercial aircraft accidents in adverse weather continue, despite frequent emphasis in TC safety newsletters and presentations on the importance of adhering to established VFR limits. In view of the occurrence record involving experienced as well as instrument-rated pilots, the Board believes that there is inadequate understanding throughout the aviation community of the risks and the consequences of operating in marginal weather conditions. A false sense of security develops when pilots and their peers repeatedly succeed in getting through marginal conditions--without incident. The Board believes that many CFIT accidents could be prevented if dangerous situations were recognized as conditions deteriorate. Therefore, the Board recommends that:

> The Department of Transport develop and implement a targeted national promotion campaign aimed at raising commercial operators' awareness of the inherent risks associated with flight operations in marginal VFR flight conditions.

A96-11

4.2.2 Pilot Decision Making

In accordance with standard investigation practice, accident pilots' decision-making processes are analyzed. The temptation to judge the quality of a pilot's decisions by the outcome, however, must be guarded against. Fairness to the individual and the advancement of transportation safety require that the actions of the pilot be understood within the context in which pilots typically are operating.

Cockpit decisions can be conceived of as having two components: situation assessment and selection of a course of action. Thus, the difficulty involved in decision making depends primarily on "the degree of clarity of the cues signifying the problem and the nature of the response options available in the situation."[4]

Cues, or information about the situation, can vary between clear and ambiguous. In situations such as emergency procedures, the cues are so strong that decision options are prescribed and the response is automatic. Sometimes, once a situation is defined or interpreted, the pilot must choose among options, or schedule tasks in the most appropriate order for the conditions. This represents a higher level of complexity. The most demanding decision making involves those situations where there are no pre-determined options. In these cases, pilots must develop their plans by using both their knowledge of the system and their assessment of the situation. The more complex and difficult a decision is, regardless of whether the difficulties are in the situation assessment component or in the response selection component, the greater the likelihood of a decision that is less than ideal. Consequently, decision tasks in the cockpit differ in the degree to which they are well-structured and thus have an agreed-upon "best" solution.

The accident pilot was familiar with the area and the aircraft. Low ceilings and poor visibility are common occurrences in the area and he had flown many hours in similar meteorological conditions. As he approached Campbell River, the ceiling at the airport was low (about 300 feet), but over the water, the clouds were about 1,000 feet above the surface.

The decision making in this occurrence required that the pilot assess the situation and choose between continuing to the airport or landing on the water at Tyee Spit, which would undoubtedly have entailed some inconvenience for the passengers. He may also have considered climbing and requesting an IFR approach, for which he was qualified and equipped.

As the pilot approached the control zone, the weather in his immediate area was above ceiling and visibility minima. The Campbell River airport reported a ceiling of 300 feet and two miles visibility, but the ceiling had been varying between 300 and 500 feet through the day and an aircraft ahead reported sighting the Campbell River runway from 900 feet asl. The pilot had an SVFR clearance which only required a flight visibility of one mile and the aircraft to remain clear of cloud. The fact that the aircraft was instrument equipped, and that the pilot was qualified for instrument flight and experienced in conducting instrument approaches into Campbell River would likely have further contributed to his confidence in continuing to the airport. The course of action selected by this pilot, based upon the existing regulations and his experience, would have been taken by many pilots with similar experience.

Once the decision to try to land at the airport was made and the aircraft turned inland, the clarity of the visual cues deteriorated. At about 2 1/2 miles from the airport, the pilot apparently changed his plan and attempted to set up an approach from the same direction as the aircraft which had reported

4 Orasanu, Dismukes, Key, and Fischer, Proceedings of the HFES Meeting 37th annual meeting, Seattle, Washington, 1993.

sighting the runway from 900 feet. It is doubtful that the pilot would modify his plan as he exited from the control zone; in principle, though, his visibility criteria increased from one mile for SVFR to two miles for VFR in designated mountainous terrain as he crossed an imaginary line at the boundary of the control zone. It is likely that his attention was focused on controlling the aircraft and his workload was heavy at this point, so that both the transition to uncontrolled airspace and the significance of it were probably not recognized at a conscious level. It appears as though he did maintain visual reference with the ground during this time.

In the light of the outcome, changing his plan and returning to Tyee Spit would have been more prudent; but the cues available to the pilot were apparently not compelling enough to change his mental model, or assessment of the situation. Once individuals select a particular course of action, it takes very compelling cues to alert them to the advisability of changing their plan. Indeed, there is a tendency to use these cues to confirm the validity of the intended plan of action[5]. This pilot had control of the aircraft, was maintaining visual contact with the ground, and was able to navigate, probably with the aid of instruments. These cues would be sufficient to lead many professional, safety-conscious pilots to continue the approach to the airport.

A recent analysis by the National Transportation Safety Board (NTSB) in the US involving 37 accidents showed that, when faced with Go/No-Go decisions, 66% of the crews continued with their current plan in the face of cues which suggested they should have abandoned it. "However, in many of these cases the cues were ambiguous and it was difficult to assess with great confidence the level of risk inherent in the situation."[6]

Inexperience, lack of knowledge, imprecise guidelines, and ambiguous cues will continue to make some pilot decision-making circumstances difficult. However, strategies to maximize the quality of decisions can be learned, and include such things as situation assessment, risk

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5 James Reason, *Human Error* (Cambridge: Cambridge University Press, 1990)

6 Judith Orasanu and Ute Fischer, "Finding Decisions in Natural Environments: The View from the Cockpit." To appear in *Naturalistic Decision Making*, ed. C. Zsambok and G.A. Klein, (Hillsdale, NJ: Lawrence Erlbaum Associates). Courtesy of the primary author.

assessment, planning, resource management, communicating, and the identification of special skill requirements[7].

Of note, increasing the SVFR minima could change the nature of decisions to be made in occurrences like the Campbell River accident. If there had been a greater minimum visibility requirement, or rules requiring a combination of ceiling and visibility, the pilot would have been faced with an easier decision. Had the previous SVFR rules been in force, the only option would have been to land at Tyee Spit. Thus, the need to re-assess the adequacy of current VFR weather minima (recommended above) should be considered in the light of normal pilot decision-making processes.

The accident pilot was operating in an environment which accepted as "normal operations" flights into marginal weather conditions, when other options, such as landing at Tyee Spit, were available. Typically, pilots involved in VFR CFIT accidents have not had any special training in decision making. At the same time, pilots flying in small air carrier operations are arguably the most exposed to such ambiguous situations with the least decision-making support. They often operate as single-person crew into a variety of unfamiliar locations with minimal infrastructure and are self-dispatched, and the aircraft do not usually possess sophisticated instrumentation or control systems.

The Board has previously recommended that Transport Canada develop and implement a means of regularly evaluating the practical decision-making skills of commercially employed pilots in small air carrier operations (TSB A90-86). TC's response in part stated:

> It has been Transport Canada's position that the benefits of this training were intrinsic in the enhanced performance of the pilot and that a properly planned and executed Pilot Proficiency Check would provide a practical and realistic assessment of a pilot's ability to make reasoned and timely decisions when faced with a simulated emergency situation. We will continue to keep abreast of developments in the field of decision-making training and assessment and will not hesitate to introduce improvements in our present system should they become available.

National and regional carriers have broadly embraced the concepts of Cockpit Resource Management (CRM) and Pilot Decision Making (PDM) training, and under the new Canadian Aviation Regulations, airline operators will be required to complete initial and recurrent CRM training. However, for other commercial operators, formal programs are being introduced on a voluntary basis. The Board believes that, given the natural human limitations in interpreting distances in marginal visibility conditions, natural human tendencies in complex decision making in the presence of changing and ambiguous cues, and
the CFIT accident record involving small commercial operators, further counter-measures are required to facilitate safe crew decision making. Therefore, once again, the Board recommends that:

> The Department of Transport require that pilots involved in air-taxi and commuter operations

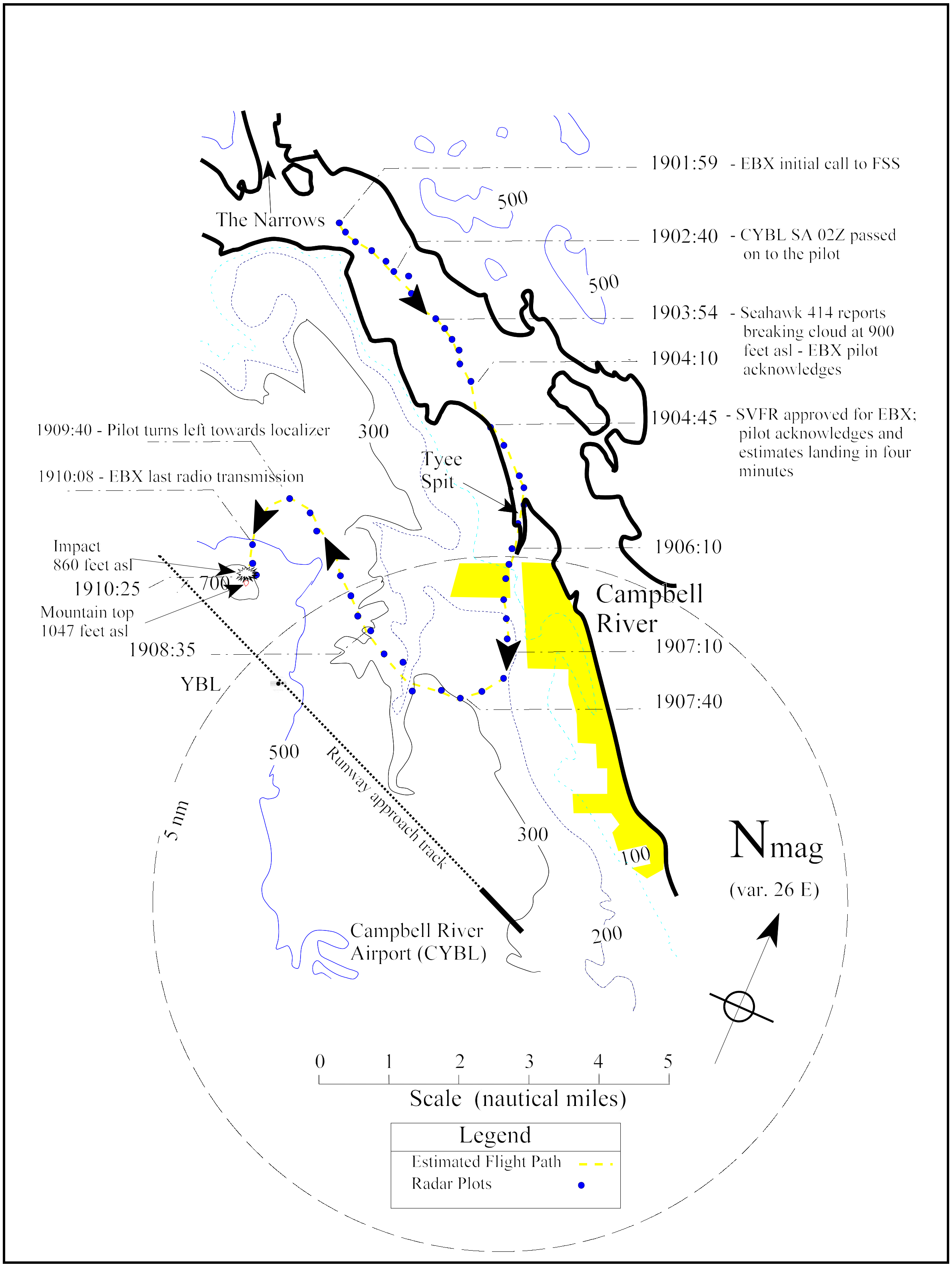
[7] Judith Orasanu, "Decision Making in the Cockpit," *Cockpit Resource Management*, ed. Weiner, Kanki, and Helmreich (San Diego: Academic Press, 1993) 137 - 172.

receive specialized training, including skills development, in making prudent decisions under deteriorating operational conditions.

A96-12

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail and W.A. Tadros, authorized the release of this report on 15 August 1996.

Appendix A - Flight Path



1901:59 - EBX initial call to FSS
1902:40 - CYBL SA 02Z passed on to the pilot
1903:54 - Seahawk 414 reports breaking cloud at 900 feet asl - EBX pilot acknowledges
1904:10
1904:45 - SVFR approved for EBX; pilot acknowledges and estimates landing in four minutes
1906:10
1907:10
1907:40
1908:35
1909:40 - Pilot turns left towards localizer
1910:08 - EBX last radio transmission
1910:25
Impact 860 feet asl
Mountain top 1047 feet asl
The Narrows
Tyee Spit
Campbell River
Campbell River Airport (CYBL)
YBL
Runway approach track
5 nm
500
500
500
300
300
700
200
100
N mag
(var. 26 E)
0
1
2
3
4
5
Scale (nautical miles)
Legend
Estimated Flight Path
Radar Plots

Appendix C - List of Supporting Reports

The following TSB Engineering Branch Reports were completed:

LP 164/95 - Technical Group Report DHC-3, C-FEBX;
LP 147/95 - Shoulder Harness Analysis;
LP 146/95 - Estimation of Crash Impact Loads;
LP 143/95 - Instrument Examination; and
LP 149/95 - Exhaust Stack Analysis Temperature Determination.

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

Appendix D - Glossary

ADF	automatic direction finder
agl	above ground level
ANO	Air Navigation Order
asl	above sea level
ATC	air traffic control
ATPL	Airline Transport Pilot Licence
CAR	Civil Air Regulation (United States)
CFIT	Controlled Flight into Terrain
C of G	centre of gravity
CRM	cockpit resource management
CVR	cockpit voice recorder
DME	distance measuring equipment
ECTM	Engine Condition Trend Monitoring Program
ELT	emergency locator transmitter
FAA	Federal Aviation Administration
FAF	final approach fix
FDR	flight data recorder
FSS	Flight Service Station
g	G load factor
GPWS	ground proximity warning system
hr	hour(s)
HSI	hot section inspection
IFR	instrument flight rules
ILS	instrument landing system
IMC	instrument meteorological conditions
lb	pound(s)
MF	mandatory frequency
NDB	non-directional beacon
nm	nautical miles
PDM	pilot decision making
PDT	Pacific daylight saving time
SAR	Search and Rescue
sm	statute miles
SVFR	special visual flight rules
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time

VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions
VNC	VFR navigation chart
VOR	very high frequency omni-directional range
YBL	Campbell River
'	minute(s)
"	second(s)
°	degree(s)
°M	degrees of the magnetic compass
°T	degrees true

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Pipeline and Rail
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Phone	(519) 882-3703
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24 Hours	(204) 983-5548
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24 Hours	(403) 495-3999
Facsimile	(403) 495-2079

CALGARY, ALBERTA
Pipeline and Rail
Sam Livingstone Building
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*Services available in both official languages