Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A98P0215

COLLISION WITH WATER

HARBOUR AIR LTD.
DE HAVILLAND DHC-2 BEAVER C-FOCJ
KINCOLITH, BRITISH COLUMBIA
4 AUGUST 1998

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

Collision with Water

Harbour Air Ltd.
de Havilland DHC-2 Beaver C-FOCJ
Kincolith, British Columbia
4 August 1998

Report Number A98P0215

Summary

The float-equipped de Havilland DHC-2 Beaver, serial number 0039, departed Prince Rupert, British Columbia, at 1719 Pacific daylight time on a visual flight rules flight to Kincolith, British Columbia, with the pilot and four passengers on board. When the aircraft arrived at Kincolith at about 1750, witnesses watched it carry out three low approaches to the water landing area, each time descending to a few feet above the water before climbing away. On the fourth approach, at about 1758, the aircraft touched down, apparently in a controlled manner, and skipped on the water surface. The floats then dug into the water followed by the right wing, which was severed from the fuselage on water impact. The aircraft quickly overturned and came to rest inverted with only the bottom of the floats visible. Several members of the village community, who had been waiting for the aircraft on the Government Dock, rushed to the sunken aircraft in small boats but were unable to rescue the pilot or passengers inside the submerged cabin. The five occupants drowned in the accident, and the aircraft was substantially damaged.

Ce rapport est également disponible en français.

Table of Contents

1.0 Factual Information

1.1 History of the Flight

Harbour Air flight 709 was a scheduled, 25-minute flight from the Seal Cove Seaplane Base in Prince Rupert, British Columbia (B.C.), to the Nisga'a First Nations village of Kincolith, B.C., about 45 nautical miles (nm) north of Prince Rupert. In the 30-minute period before the passengers boarded flight 709, the company dispatchers at the Harbour Air terminal counter checked-in the passengers. Personal baggage and miscellaneous freight were weighed, prepared, and loaded into the aircraft. The passengers were three adult females and a nine-year-old boy.

During the pre-flight discussions with the Kincolith agent and the Prince Rupert dispatcher regarding the existing flight conditions, the occurrence pilot was given an option that if he was uncomfortable with the conditions, another company pilot could be called to complete the trip, without prejudice to him. The occurrence pilot assessed the conditions as within his ability and declined the offer. However, he indicated that he would assess the conditions in Kincolith and return to Prince Rupert if he judged them unsuitable for landing.

At about 1710,[1] the pilot and passengers boarded the aircraft. Witnesses at the dock reported that the boy was seated between two female passengers in the centre of the first row of cabin seats behind the pilot and that the third female passenger occupied the right front seat. Following routine safety briefings, the pilot taxied out from the dock. At 1719, the aircraft took off from Prince Rupert, 19 minutes later than the normal scheduled take-off time.

The flight to Kincolith was apparently unremarkable since the pilot had not reported anything to the contrary to either the company dispatchers during radio communications, the Prince Rupert flight service station, or other aircraft in the area.

1.2 Injuries to Persons

	Crew	Passengers	Total
Fatal	1	4	5
Serious	-	-	-
Minor/None	-	-	-
Total	1	4	5

1.3 Damage to Aircraft

The aircraft was substantially damaged by impact forces, by the subsequent attempts to rescue and recover the occupants, by the efforts in bringing the aircraft to shore, and by wave and tidal action after the aircraft was towed ashore. An examination of the wreckage, except for the

1 All times are Pacific daylight time (PDT) (Coordinated Universal Time [UTC] minus seven hours) unless otherwise noted.

missing right wing, revealed no pre-existing malfunction or defect with the aircraft or any of its systems that would have caused or contributed to the accident.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

The 49-year-old pilot-in-command had been employed by Harbour Air as a part-time pilot since May 1996, flying only during the summer periods of higher flying activity in Prince Rupert. He held a valid Canadian Commercial Pilot Licence and Medical Certificate. He had accumulated a total of about 1,700 flying hours, about 150 hours of which were in light Cessna and Piper aircraft, about 300 hours on the de Havilland DHC-6 Twin Otter as a first officer, and about 1,250 hours on the de Havilland DHC-2 Beaver. His most recent pilot competency check with the operator was in February 1998 and was carried out satisfactorily, as it had been on previous occasions. The pilot had not received any formal underwater evacuation training, nor was any required by regulation. The pilot also held a hovercraft operator licence, and during the periods of inactivity with Harbour Air, he operated hovercrafts on contract in Peru.

1.6 Aircraft Information

Manufacturer	de Havilland Aircraft of Canada
Type and Model	DHC-2 Beaver
Year of Manufacture	1949
Serial Number	0039
Certificate of Airworthiness	Valid
Total Airframe Time	22,369 hours
Engine Type	Pratt & Whitney R-985 AN-14B
Propeller Type	Hamilton Standard 2D30-237
Maximum Allowable Take-off Weight	5,090 pounds
Recommended Fuel Type	AvGas 100 LL
Fuel Type Used	AvGas 100 LL

According to documents recovered after the accident, the weight and balance of the aircraft at take-off from Prince Rupert was calculated to be within certificated limits. When the aircraft left the dock at Seal Cove, it weighed about 4,500 pounds. It contained 200 pounds of baggage and cargo, 300 pounds of fuel, and the pilot and four passengers were calculated at 630 pounds, based on Transport Canada(TC)-approved standard summer weights.

An examination of the aircraft and engine maintenance records and other documentation revealed nothing remarkable and showed that the aircraft was certificated, equipped, and maintained in accordance with existing regulations and approved procedures.

The aircraft was being operated in accordance with *Canadian Aviation Regulations*, Part VII - “Commercial Air Services”, subpart 703 - “Air Taxi Operations”, and in accordance with Air Operating Certificate number 5473, issued to Harbour Air by TC. The most recent TC audit of Harbour Air was conducted in March 1998. In this audit, the TC audit team made only five minor findings concerning documentation, none of which bore any consequence to this accident.

1.7 Meteorological Information

There is no formal weather observation system in place in Kincolith. However, weather reports and updates are transmitted frequently from the air carriers’ village agents to their dispatch offices by telephone or radio. The Prince Rupert Flight Service Station provides pilots operating in the Prince Rupert area with weather data compiled by the Canadian Atmospheric Environment Service.

In general, the weather in the local area was being influenced by a cold front, advancing slowly eastward. This moist unstable air mass was producing scattered cloud at 4,000 feet, with variable and broken ceilings at 7,000 and 14,000 feet above ground level (agl).

The aviation routine weather report (METAR) at 1800 PDT for Prince Rupert, 45 nm south of Kincolith, recorded a northwest wind at 8 nautical miles per hour (knots), visibility of 15 statute miles (sm), a broken cloud layer at 7,000 feet agl, and a temperature of 16° Celsius (C). The 1800 PDT METAR for Stewart, 55 nm north of Kincolith, recorded no wind, visibility of 15 sm, broken cloud layers at 6,500 and 8,000 feet agl, and a temperature of 20°C.

At the time of the accident, people on the Government Dock reported that the wind in their area was northwesterly, in the order of 20 knots, with frequent gusts.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

Direct communications between the company agent in Kincolith and the Prince Rupert dispatcher is provided by telephone. However, there is no telephone at either dock. As a result, if the agent is at the dockside waiting for an arriving or departing aircraft, there is no means of communication during the approach, landing, and take-off phases of any flight. Furthermore, there is no longer direct radio communication between the pilots and the Kincolith agent. Any information from the pilot is first transmitted by radio to the Prince Rupert dispatch, then relayed by them to the agent in Kincolith, again provided that the agent is at a telephone.

Hand-held frequency modulation (FM) radio transceivers were used several times in the past but, over time, they were lost in the water. The village of Kincolith has a citizen's band network in place since the village telephone system is reportedly unreliable.

Direct communications between Harbour Air pilots and company dispatch in Prince Rupert is achieved by either FM radio, high frequency radio, or very high frequency radio. Because of the terrain and local weather conditions, two-way radio communication is frequently unreliable.

1.10 Water Aerodrome Information

At Kincolith, there are two serviceable and suitable docks that the Beaver aircraft can use: the Village Dock, located on the eastern edge of the village itself, and the Government Dock, about 0.8 nm west of the village. Given the choice, passengers and pilots prefer the Village Dock since it is more conveniently located and since village access from the Government Dock is only by a circuitous and poor gravel track.

Wind and tidal conditions usually dictate which of the docks is used on any particular occasion. Kincolith is in Nass Bay, located at the head of the tidal Portland Inlet at the confluence of three significant bodies of water: the Portland Canal, the Observatory Inlet, and the Nass River. Wind conditions in the area are heavily influenced by the valleys, and strong winds often occur in directions contrary to the tide and wave action. Nass Bay is affected significantly by the tide and contains extensive mud and sand drying flats that are exposed during low tide; these create sharply defined areas of inconsistent and turbid surface conditions. As a result, the water and wind conditions at Kincolith are frequently unpredictable and change rapidly. Floatplane pilots in the Prince Rupert area regard water landings at Kincolith as challenging. Thus, Prince Rupert aircraft operators frequently cancel flights into Kincolith because of local conditions.

According to the Canada Water Aerodrome Supplement (WAS) in effect on the day of the accident, Kincolith has a tidal range of 18 feet. The Village Dock can only be used by floatplanes when the tides are greater than 11 feet. At the time of the accident, the tide was at or near the low tide point of 8.9 feet. The WAS also contains the caution "Subject to Heavy Seas". As a result of the reported wind and tidal conditions on the day of the accident, Harbour Air flight 709 had planned to tie up at the Government Dock rather than the Village Dock. According to information from Canadian nautical chart 3920, the drying flat Governors Bar immediately offshore from the village would have been exposed, and the edge of the bar would have been covered with about 3 feet of water. Wind at the time was reported to be northwesterly, in the order of 20 knots, with frequent gusts.

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

The inverted aircraft was towed to shore by first responders and secured. During the villagers' attempts to right the aircraft onto its floats, the left aileron, the horizontal stabilizer, the tail section, and the right float were unintentionally damaged, and the right elevator was torn off.

The right wing, lift strut, flap, and aileron, were torn off at water impact and sank. These parts were not recovered. The forward and aft wing attachment lugs on the right wing had broken off but were retained with their mating fuselage attachment lugs. Both broken pieces of the lugs were bent aft, and both fuselage lugs were spread and bent aft. The lower attachment fitting on the fuselage for the lift strut had fractured. All damage to the fuselage wing fittings, the flap push-pull rod, the torque-tube outboard bellcrank, and the wing root was consistent with the wing having been torn off at water impact.

The left wing remained attached to the aircraft, and the lift strut, fairings, flap, and aileron were intact. The left flap was in the landing position, the trailing edge was bent, and the actuating linkage was intact and undamaged. The left aileron was attached and the wing tip was intact.

The horizontal stabilizer and vertical fin remained attached. The elevator and rudder control cables and trim cables were intact and undamaged. The left elevator was intact and attached; the right elevator was detached and damaged. The left elevator trim tab was in the full nose-up position, and the elevator trim drum was in the neutral position. The rudder remained attached, and the rudder trim tab was deflected about one inch nose right, which is nearly full travel. Technical examinations of the flight control trim systems revealed that impact to the rudder trim tab itself would not change the associated indicator in the cockpit. However, the elevator trim tab linkages are susceptible to damage from external impact forces and, as a result, can be inconsistent with the cockpit indicator. All the struts, fittings, wires, and control cables for the floats were intact.

The fuel hoses in the fuel selector bay were in place and without damage. The fuel selector remained connected to the fuel selector valve, was free to turn, and was selected to the front tank. The fuselage and cabin were intact and had minor damage. All the windows were in place and unbroken, except for the pilot's sliding window which was in place but cracked horizontally at the window base. All of the seats remained attached to the floor. The floor and seats were undamaged. The aircraft doors were examined and found functional and without defect. Both cabin doors had L-shaped interior and exterior handles. They turned freely and the latching mechanism functioned correctly. The front doors, handles, and latches were tested, and no defect was found. The top portion of the pilot's door was bent back during the rescue attempts and subsequent recovery. First responders reported that, when they arrived at the aircraft, all the doors were closed. Later, they reported that the handles and latches operated freely and opened without difficulty. Seven of the eight life jackets on board the aircraft were accounted for.

In the cockpit, the throttle, mixture, and propeller pitch levers were in the fully forward position. The flap pump handle was up and the flap selector lever was down. The flap actuating jack and the flap position indicator were in the landing position. The elevator trim position indicator was slightly nose-down, and the rudder trim indicator was nearly fully right.

There was no apparent damage to the engine. All engine controls were attached and functional, and all lines, hoses, and electrical connections were unremarkable. The two-bladed metal propeller was unremarkable except for one blade which was bent slightly forward.

No indication was found of any malfunction or pre-existing mechanical defect in the aircraft, its engine, or its systems that could have caused or contributed to the accident.

The Pointer Sentry model C-4000 emergency locator transmitter (ELT), serial number 4700670, was secured to the left side of the fuselage, behind the baggage compartment. The ELT switch was in the armed position. The antenna co-axial cable was connected to the ELT, as was the remote switch cannon plug. The remote switch was in the auto position. The aircraft antenna was intact. No ELT signal was received by search and rescue units.

1.13 Medical Information

Post-accident medical information reveals that all the occupants died by drowning. Medical information also reveals no remarkable trauma to the occupants, suggesting that the impact forces were tolerable and survivable, and that the occupants had been restrained during the initial impact and rollover. There was no indication that incapacitation or physiological or psychological factors affected the pilot's performance.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The five occupants were found unrestrained in the inverted aircraft cabin by rescuers. Their injuries and the damage to the aircraft and cabin structure are inconsistent with those of unsurvivable accidents. This aircraft was fitted with three-point lap belt and shoulder strap personnel restraints for the two front seats and with conventional two-point lap belts for all cabin seats. The personnel restraint for the right front-seat passenger was found still fastened, and the pilot personnel restraint and the passenger seat belts for the seats occupied by the other three passengers were found undone and serviceable. No conclusion about the use of the restraint systems on this flight can be made. The passengers were all frequent flyers of floatplanes in the Prince Rupert area and would have been familiar with general seat belt safety and operation. In addition, it was Harbour Air's policy to conduct a passenger safety briefing before all flights which included seat belt fastening and adjustment.

When the aircraft taxied away from the Seal Cove dock, the right front seat was occupied by an identified female passenger. It is likely that this passenger would have been wearing a personnel restraint during the flight. This personnel restraint incorporates a single, diagonal shoulder harness which attaches to the adjustable lap belt. The shoulder harness is attached to an inertia reel lock system in the right interior wall of the cabin, near the roof. When worn correctly, the shoulder strap passes over the occupant's right shoulder, across the centre of the chest, and attaches to the seat belt buckle at the left hip, in a fashion similar to a modern automobile seat belt. However, in this accident investigation, the personnel restraint was found still fastened, with equal lengths of webbing on each side of the lap belt buckle fitting. The seat belts had not been interfered with.

It could not be determined why the occupants did not escape from the aircraft. The doors were found functional and without defect. The interior and exterior handles on both cabin doors were found to turn freely, and the latching mechanisms functioned correctly. The pilots' doors, handles, and latches were also tested and no defect was found. The top portion of the pilot's door was bent back during the rescue attempts and subsequent recovery. None of the occupants was wearing a life jacket. Eight life jackets were on board the aircraft when it left Kincolith.

No existing Canadian regulations require a commercial, air taxi, or floatplane operator to provide underwater evacuation training to its pilots or cabin attendants. In the past and on a voluntary basis, Harbour Air had provided underwater evacuation training to some of its floatplane pilots.

1.16 Tests and Research

In 1994 the TSB published a study[2] on 234 fatal seaplane accidents between 1976 and 1990. Seventy-eight per cent of these accidents occurred during the take-off or the approach and landing phase of the flight and 103 were known to have terminated in the water. In these 103 accidents, 276 occupants were involved and 168 were fatalities. The TSB study found that relatively few of these deaths occurred during the impact sequence. In fact, 70 per cent of those who died perished as a result of post-impact drowning and half of them drowned inside the aircraft's cabin. During water accidents, the aircraft often overturns and the occupants become disoriented. Water rushing into the cabin in the seconds after impact in addition to disorientation could cause the occupants to panic. The study notes that *"Actuating a simple door-opening mechanism can become an almost impossible task in cold, dark water when the aircraft cabin is vertical or upside-down"*. In 1988 the Canadian Aviation Safety Board (CASB) conducted a study[3] which, in part, pointed out that *"Often the aircraft became inverted in the water, suspended by the floats"*.

Although the TSB study found that the majority of fatal seaplane accidents in the water involved drowning, about 10 per cent of the victims were incapacitated from non-fatal impact injuries. The Board recognized that *"... an effective restraint system may secure the occupants of the aircraft during even cart-wheeling impact forces, better enabling them to find the exits if the aircraft comes to a stop inverted and sinking in the water"*.

---

2 *A Safety Study of Survivability in Seaplane Accidents* [SA9401], TSB 1994.

3 *The Carriage and Use of Overwater Life-Support Equipment in Canada,* CASB, (88-SP001), 1988.

A safety information brochure[4] from the U.S. Department of Transportation emphasizes that shoulder harnesses are effective in reducing injury and death in light aircraft mishaps, and places particular focus on the correct placement of the shoulder strap. In part, the brochure advises that *"Single diagonal shoulder belts should be positioned so that the torso's centre of gravity falls within the angle formed by the shoulder belt and the safety belt. Otherwise your torso may roll right out of the shoulder belt during an impact and compromise your protection"*.

The brochure further advises that *"... the safety belt buckle should be positioned on the side of your hip,"* and that this position *"... differs from the central location of the buckle that is common when only the safety belt is used"*.

1.17 Other Information

Harbour Air in Prince Rupert has a designated company agent in several of the outlying villages that they service on a regular basis. Among other duties, the agents provide first-hand reports of the current weather and water conditions in their areas to the main dispatch office in Prince Rupert. Here, the information is given to the pilots of the affected flights who make the operational decisions as to whether the flights will continue. In the event the weather conditions are reported as unsuitable, the affected flights are either postponed or cancelled. If the conditions are reported as marginal, the pilots usually speak directly to the agents to get a better understanding of the conditions. Pilots often fly with the intention of returning to Prince Rupert if they judge the conditions are actually unsuitable for landing. On several occasions in the month prior to the accident, pilots had returned from Kincolith and other outlying villages because the landing conditions had remained unfavourable. In the past, the occurrence pilot reportedly had also returned from unsuitable water landing areas.

When faced with difficult weather or water surface conditions, seasoned floatplane pilots in the Prince Rupert area report that it is a common practice for them to carry out a number of practice approaches in order to assess the wind and water conditions and to choose the best landing profile and area. In addition, although full right rudder trim may be used by DHC-2 pilots during the take-off run on water and on initial climb-out, a similar amount of right rudder trim is not normally required during the approach and landing on water.

Difficult landing conditions occur from time to time at many of the outlying villages serviced by Harbour Air. The company asserts that it emphasizes to its less experienced pilots that if they are uncomfortable with the conditions, another company pilot can be called to complete the trip without prejudice to the pilots that decline to fly. In addition, given the occurrence pilot's lack of experience in outlying areas, the company had routinely scheduled him to fly to less difficult water landing sites. The company maintains that he would still have been paid had he decided to let another pilot conduct this flight.

---

4 *Smart Protection in Small Airplanes* (AM-400-91/2), U.S. Department of Transportation, Federal Aviation Administration, 1991.

2.0 Analysis

2.1 General

This investigation included an examination of environmental, technical, human, and operational factors as well as mechanical aspects of this aircraft, its component parts, and their service life and history. No indication was found of any malfunction or pre-existing mechanical defect with the aircraft, its engine, or its systems that could have caused or contributed to the accident. As a result, this analysis focusses on selected operational aspects of the accident.

2.2 Aircraft Control

Witnesses reported that the first three approaches and the touchdown appeared to be normal and controlled. This would suggest that the pilot was not experiencing any abnormal aircraft control function and that he was capable of controlling the aircraft.

In concert with the reported wind and water conditions, the brief accident sequence observed by the village people is consistent with two possible scenarios or a combination of the two:

a. on initial touchdown in a left-crosswind condition, the left float struck a swell or wave which forced the aircraft into an attitude that the pilot was not able to control before the float(s) or wing dug into the water and caused the aircraft to overturn; or

b. the aircraft was upset by a wind gust at or shortly after touchdown which the pilot was not able to control before the float(s) dug into the water and caused the aircraft to overturn.

Technical examination of the rudder trim system revealed that it was not significantly damaged, and there was no indication that the trim cables had been disturbed on impact causing the trim to move. Furthermore, due to its design, impact to the trim tab itself would not have changed the trim indication in the cockpit. Although the rudder trim tab and rudder trim indicator both had captured indications of nearly full right rudder trim setting, it could not be determined if this setting had been deliberately selected by the pilot, or when he had selected it. Almost full right rudder trim is not normally employed by pilots for landing on water and likely would not go unnoticed by a pilot. Such a trim setting can be used in the take-off and climb phases without adverse effect on the flying characteristics of the aircraft. Had it been so set during the approach and landing phase, it would not have rendered the aircraft uncontrollable.

2.3 Water Conditions

Witnesses reported that the water surface conditions were rough when the aircraft attempted to land. Therefore, it is most likely that the pilot made the first three approaches to assess the wind and water conditions and to determine the best water surface on which to finally land.

Experienced floatplane pilots find that wind and water conditions in Kincolith are generally challenging to land in because of the water and topography surrounding Nass Bay. On the day of the accident, several local environmental conditions, such as exposed mud flats, unpredictable and inconsistent water chop, and conflicting wind and swell directions, compounded the difficulties faced by the occurrence pilot.

It is likely that the earlier inflow wind conditions had created a significant southwesterly swell in the Portland Inlet and Nass Bay, and that swell would have intensified over the shallow bar off Kincolith. At the time of the accident, the wind had reportedly changed to the northwest. The direction of the approaches that the aircraft was seen to fly was apparently parallel to the swell and would have presented a left crosswind situation for the pilot. While it would have been possible for the floatplane to land uneventfully in such conditions, the level of risk would have been elevated and the attendant margin for error reduced.

2.4 Right Front Seat Personnel Restraint Adjustment

When the right front seat personnel restraint is worn correctly, the shoulder strap passes over the occupant's right shoulder and chest, and attaches to the seat belt buckle fitting at the left hip. In this accident, the buckle was found in the centre of the lap belt, indicating that the buckle would have been near the middle of the passenger's abdomen, not on her left side. With such lap belt adjustment, the shoulder harness would have passed over the right side of her torso and upper right arm. As a result, in the event of any significant deceleration, it is most likely that her upper body would not have been restrained effectively because she would have rolled out from the shoulder strap. In this accident, with a rapid overturn, it is conceivable that the passenger could have then slipped out from the loose personnel restraint while it remained fastened. The adjustment procedure for the lap belt portion of the right front seat's personnel restraint is different from the lap belt of the cabin seats because it has to allow for the correct placement of the shoulder strap at the left hip. It is possible that the practice of adjusting the cabin lap belt to the centre of the body influenced the adjusting of the seat belt in the right front seat.

2.5 Survivability

Although all the occupants were found released from their personnel restraints, and since no information to the contrary exists, it is most probable that the passengers would have used the seat belts at take-off, during flight, and on landing.

Notwithstanding that the doors were functional and without defect, it could not be determined why the occupants did not escape from the aircraft. However, when the aircraft overturned and rapidly sank, it is probable that the occupants became disoriented in the dark and frigid water and panicked. In addition to these factors, the confined and inverted cabin would have made the normally easy action of locating and operating the door handles a most challenging task, especially after undoing their seat belts and, thereby, further losing reference to their relative locations. Had the pilot been trained in or exposed to underwater evacuation techniques, he may have escaped, and at the same time, he may have assisted others in escaping from the inverted aircraft cabin.

3.0 *Conclusions*

3.1 *Findings*

1. The pilot was licenced and qualified in accordance with existing regulations.

2. Maintenance records indicate that the aircraft was certificated, equipped, and maintained in accordance with existing regulations and approved procedures.

3. No indication was found of any malfunction or pre-existing mechanical defect with the aircraft, its engine, or its systems that could have contributed to the accident.

4. The aircraft's weight and centre of gravity were calculated to have been within certificated limits.

5. The prevailing weather and water conditions at Kincolith are frequently challenging and increase the level of risk for aircraft operations into Kincolith.

6. Conflicting wind and water conditions at the time of the occurrence was a factor which contributed to the accident.

7. Direct radio communication between the Kincolith agent and arriving aircraft was not operational at the time of the accident.

8. During the period when the Kincolith agent was waiting for the aircraft at the dock, direct communication between the agent and the operator's dispatch office in Prince Rupert was not possible.

9. While the accident aircraft was landing at Kincolith, direct communication between the pilot and the Prince Rupert dispatch office was intermittent and not assured.

10. The rudder trim was found in the nearly full-right position; it could not be determined if or when the pilot selected this setting.

11. The passenger occupying the right front seat most likely slipped out of the personnel restraint when the aircraft nosed over.

12. The adjustment for the lap belt of the right front seat was incorrect and diminished the efficacy of the shoulder belt.

13. Although sufficient life jackets were onboard, neither the pilot nor passengers were wearing life jackets.

14. The aircraft doors were functional and opened without difficulty during tests after the accident.

15. The impact forces were survivable.

16. It could not be determined why the occupants did not escape from the aircraft.

17. Research shows that escape from an aircraft, overturned in the water, is infrequent, hazardous, and difficult.

18. No existing Canadian regulations require floatplane operators to provide underwater escape training for pilots and cabin attendants.

3.2 Causes

On touchdown, the float(s) struck the water and caused a flying attitude that the pilot could not control before the right wing dug in and the aircraft overturned. Contributing to the accident were conflicting wind and water conditions at the time of the occurrence.

4.0 Safety Action

4.1 Action Taken

4.1.1 Escape from a Submerged Seaplane

It was determined that the occupants were restrained during the initial impact and rollover, and the impact forces were tolerable and survivable. The aircraft's doors were functional and opened without difficulty. It could not be determined why the occupants did not escape from the aircraft.

The TSB identified 24 fatal seaplane accidents in Canada between 1 January 1990 and 1 July 1999 in which the flight terminated in water. These accidents resulted in 43 fatalities. In 29 of them, egress from the aircraft had not been achieved. Of these 29 fatalities, 23 did not occur on impact. Eleven of these 23 fatalities had sustained serious injuries during the accident impact. A physical impediment to egress, such as damaged exits or cargo blocking an exit, was a factor in 9 of these 23 fatalities. (These factors are not mutually exclusive.) Of these 23 fatalities, 7 did not have serious impact injuries and exits were not blocked. About half of the accidents and fatalities involved commercial operators. The annual accident rate was fairly constant during this time period, and the accidents were not concentrated in any particular geographic location.

The psychological and physiological challenges associated with escaping from a submerged seaplane can be profound and can include the need to quickly locate, reach, and open an unfamiliar exit in cold dark water and in an inverted and distorted cabin while suffering from shock and injury. However, physical impediments associated with escaping from a submerged seaplane are often surmountable. It is likely that many people do not escape because they are not prepared to do so.

In 1993, the TSB released *Safety Study of Piloting Skills, Abilities, and Knowledge in Seaplane Operations* (report number SSA93001) which examined 1,432 seaplane accidents. Although the study did not focus on survivability issues, it did compare the ratio of fatal accidents to total accidents for float-equipped aircrafts to that for wheel-equipped aircrafts (for makes and models of aircrafts most frequently float-equipped). For airplanes that were on wheels, 10% of the accidents were fatal, but when on floats, 17% were fatal.

The study made 10 safety recommendations aimed at reducing the number of seaplane accidents. In addition, the TSB released *Safety Study of Survivability in Seaplane Accidents* (report SS9401) in 1994. To enhance survivability in seaplane accidents, six safety recommendations were made. Despite the actions taken in response to both sets of recommendations, the number of seaplane accidents has remained fairly constant and the ratio of fatal seaplane accidents to total seaplane accidents has increased.

A requirement exists for aircrafts to be equipped with occupant restraint systems. These systems reduce the likelihood of injury on impact, thus increasing the chances of egress. Also, commercial operators are required to provide pre-flight safety briefings to passengers which include information on the location and operation of exits. Despite these defences against occupants not escaping from a submerged seaplane following a crash, accident histories indicate that the risk of drowning due to inadequate preparation for escape is still high.

Given some unnecessary risk associated with underwater egress from crashed seaplanes and the apparent lack of initiatives within the seaplane community to address the issue, on 02 March 2000, the TSB issued Aviation Safety Advisory A000003-1 to TC. It suggested that TC consider reviewing the previous safety recommendations contained in the TSB safety studies in order to develop effective measures that would enhance the likelihood of escape from cabins of submerged seaplanes.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 6 April 2000.

Appendix A - Glossary

agl	above ground level
B.C.	British Columbia
CASB	Canadian Aviation Safety Board
ELT	emergency locator transmitter
FM	frequency modulation
knots	nautical miles per hour
METAR	aviation routine weather report
nm	nautical mile
PDT	Pacific daylight time
sm	statute mile
TC	Transport Canada
TSB	Transportation Safety Board of Canada
WAS	Canada Water Aerodrome Supplement
°	degree