AVIATION INVESTIGATION REPORT

A99P0136

COLLISION WITH BOAT

WEST COAST AIR LIMITED
DE HAVILLAND DHC-2 BEAVER C-GSUE
VANCOUVER HARBOUR, BRITISH COLUMBIA
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Summary

The de Havilland DHC-2 Beaver floatplane, serial number 1199, was on a scheduled visual flight rules flight from Victoria Harbour to Vancouver Harbour, British Columbia, with the pilot and six passengers on board. The pilot flew a standard arrival from Queen Elizabeth Park checkpoint to Vanterm checkpoint in preparation for a landing towards the west in Vancouver Harbour. When the aircraft was on final approach, at about 400 feet above sea level, the pilot received clearance to land from the Vancouver Harbour control tower. Just as the aircraft was about to touchdown at about 1639 Pacific daylight time, the pilot heard a "thump" sound and felt the aircraft shudder. The pilot did not see the small pleasure boat and was not aware of its presence until the impact. He immediately terminated the landing attempt, applied power, and initiated a climb. He then reported by radio that he was overshooting and he felt something had hit the aircraft. The pilot flew the aircraft to a position where the air traffic controller from Vancouver Harbour Tower was able to visually confirm that the aircraft appeared to be undamaged. The pilot then landed the aircraft in the harbour without further incident. As a result of the collision, the operator of the boat suffered serious injuries and the passenger received minor ones. There were no injuries to the occupants of the aircraft, which was not damaged during the collision.

Other Factual Information

When the pilot was cleared to land from the Vancouver Harbour control tower, the aircraft was about 400 feet above sea level (asl), the boat was located, approximately, at the pilot's 11 o'clock to 1130 position. The pilot flew a steady final approach, with a descent rate of about 800 feet per minute, and gradually reduced speed from about 80 knots at the beginning of the approach to about 40 knots just prior to touchdown. Approximately 29 seconds had elapsed between the time when the landing clearance was issued and the pilot reporting that he was overshooting. Allowing a few seconds for the pilot to assess the situation, initiate a climb, and make a radio transmission, about 25 seconds are estimated to have elapsed between the issuance of landing clearance and collision.

The air traffic controller was seated at his working station, at the time of the collision. He was controlling several aircraft and was alone in the tower at the time. The controller did not see the boat prior to issuing a landing clearance, and he did not monitor the landing aircraft or the landing area after issuing the clearance. The controller's attention was diverted toward other aircraft within the control zone and was not focussed on the landing aircraft until the pilot reported the overshoot. The controllers' Manual of Operations does not require that a controller monitor the landing area or aircraft to touchdown.

The operator of the boat was a tourist and had rented the boat from an agency on Granville Island; he had rented similar boats on at least two prior occasions. He and his passenger (also a tourist), planned a sightseeing excursion to Vancouver Harbour and back. They started their return journey to Granville Island from the east side of the Vancouver Trade and Convention Centre (Canada Place) and proceeded on a track toward Brockton Point (about 340°).[1] The boat's course was initially parallel to the east side of Canada Place, then curved toward Brockton Point once clear of the pier. The boat's speed was constant at about eight knots during this time and its course steady. The operator of the boat was sitting on top of his seat with his feet on the seat cushion and was facing inwards, discussing boat operations with the passenger. He did not see the aircraft approaching.

The operator of the boat sustained serious injuries as a result of the collision, including several broken ribs, lacerations to his head and back, and a collapsed lung. He was hospitalized in Vancouver for several days prior to being transferred to a hospital in his native land. The passenger of the boat sustained minor injuries, mainly consisting of small lacerations due to flying glass from the boat's shattered windshield. The pilot and six passengers on the aircraft were not injured. The collision occurred within the confines of Area Alpha which is a designated seaplane landing zone and is depicted on the Canadian Hydrographic Service's Nautical Chart #3493 - Vancouver Harbour Western Portion (see Appendix A).

A private vessel was the first to arrive on the scene within about one minute of the collision. The captain of the private motor vessel radioed Vancouver Harbour Vessel Traffic Services on marine band very high frequency (VHF) channel 12 and was quickly joined on the scene by Coast Guard and Vancouver Harbour Master vessels. In addition, the Sea Bus was able to transfer a medical technician to the Harbour Master vessel who was then transported to the stricken vessel and administered first aid. All these activities took place within a few minutes of the collision.

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[1] All directions measured with respect to True North.

Weather at the time of the occurrence was reported as CAVOK[2] on the Vancouver Harbour tower automatic terminal information service (ATIS),[3] with a wind from 250° at 5 to 10 knots. Temperature was 15° Celsius. Landings were being carried out toward the west. The sea was mostly calm, with light ripples on the water. The sun's position at the time was approximately 240° in azimuth and 21.5° above the horizon. Sunlight was reflecting off the water's surface, creating a large area of bright glare. Witnesses who viewed the collision from boats on the water assessed the glare to be extreme, accentuated by the light ripples on the water's surface. The aircraft's final approach course was about 250°, and the glare patch on the water coincided with the position of the boat as the aircraft descended down the last few hundred feet toward the water (see Appendix A).

Records show that the pilot and air traffic controller were certified and qualified in accordance with current regulations. The operator of the boat was not required to be certified by any regulation.

The pilot held a Canadian commercial pilot's licence. He had accumulated about 1800 hours of total flying experience at the time of the collision, with about 1300 hours on type, including about 275 hours in the preceding 90 days. The majority of his flying experience was on float- equipped aircraft and he had also trained general pilots for seaplane ratings with several pilots. He had been working out of the Vancouver area for about 20 months and estimated that he had landed in Vancouver Harbour on at least 200 occasions. He was on duty for 9.5 hours prior to the collision and had been off duty for 14.5 hours before beginning work that day. These duty times are within the guidelines and regulations set out by Transport Canada (TC).

The air traffic controller had accumulated more than 10 years' experience as a visual flight rules (VFR) controller and had been working in the Vancouver Harbour control tower for about nine years. He was on duty for 5.25 hours prior to the occurrence and had been off duty for 15.75 hours before beginning work that day. These duty times are within TC guidelines and regulations. The approved staffing level document for Vancouver Harbour Tower dictates that only one controller is required to be on duty during weekend hours of operation. Two controllers were on duty that day. However, the second controller was on a break at the time of the collision and was not present in the tower cab.

Area Alpha is labelled on the nautical chart as advisory only and vessels are not obligated to steer clear of the area. However, due diligence and a good lookout for seaplanes when operating a vessel within the area are strongly advised.[4] The operator of the boat was not aware of any specific area used for seaplane landings; however, he was aware that aircraft routinely operated in and out of Vancouver Harbour. He was not consulting a chart at the time of the collision and no charts could be found on the boat. Area Alpha is also depicted on the Vancouver Harbour pages of the *Water Aerodrome Supplement*, published by Geomatics Canada. The area and its dimensions were well known to both the pilot and tower controller.

The pilot was about six feet two inches tall and flew with his seat in the full aft position. Sight lines from the cockpit, looking forward, are restricted by a windshield centre post and two side posts. Sight lines from the cockpit, looking to the sides, are masked by the aircraft's structure. To view the area on the left, the pilot must move his head slightly down and forward, then look out the window in the cockpit door. This obstruction to the left side is enhanced by the left windshield post in that the post joins the area above the window. These cabin

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2 Ceiling And Visibility OK: No cloud below 5000 feet; visibility six miles or more; no precipitation, shallow fog, or low drifting snow.

3 Refers to repetitive transmission of essential but routine information for arriving and departing aircraft.

4 *Sailing Directions, BC Coast (South Portion)*, Vol 1, 16th Edition, p. 173

structures create one continuous obstruction to vision extending from below the nose of the aircraft, along the windshield post, to the pilot's left side.

The pilot did not wear glasses or sunglasses, and his vision was 20/20, uncorrected. The human eye has certain limitations, is susceptible to glare and has blind spots. Studies have shown that glare decreases visual effectiveness significantly.[5] In addition, when two objects are on a collision course and the two velocity vectors are constant with regard to speed and heading, then each object has a constant relative bearing to the other.[6] There was a small shift in the relative bearing between the boat and the aircraft since the aircraft's speed was decreasing. Accordingly, the relative motion between the two objects was minimal, which may have made it difficult for the pilot to see the boat.[7] Furthermore, each eye has a blind spot at the optic nerve head, where the optic nerve joins the retina. If vision of an object by one eye is obstructed by a windshield post, for example, then a visual target could be in the blind spot of the other eye and remain undetected.[8] Moving the head and eyes changes the relative position of these blind spots and helps minimize the masking effects of the obstruction. TSB investigators flew with the pilot a few months after the collision and he was observed to rarely check or clear the blind spot to his left.

Standard operating procedure for air traffic controllers dictates that the manoeuvring area and runway surface will be scanned and assessed for potential conflicts prior to issuing landing clearance.[9] Vancouver Harbour is unique in that the "runway" is a large area (Area Alpha), versus a single piece of pavement. Aircraft are cleared to land, but the controller can only estimate where the aircraft will contact the water. In addition, Vancouver Harbour controllers only control aircraft. They do not communicate directly with boating traffic, have no authority to control the movements of boats, and can only estimate their movements. The controller must scan a large area of water and assess the movements of numerous targets in order to determine if the "runway" is clear. When the controller determines that a potential conflict exists, an advisory will be communicated to the pilot outlining the potential conflict. Nevertheless, when cleared to land in Vancouver Harbour, ultimate responsibility for ensuring the prospective landing area is obstacle free remains with the pilot.

The Vancouver Harbour Control Tower is located at the top of a high-rise building, at the foot of Granville Street, at an elevation of about 465 feet asl. The view throughout 360° is mostly obstruction free; however, sight lines to areas directly below the cab are limited. At the time of the collision, only the northernmost portion of Canada Place was visible from the controller's seated, working position. However, all of Area Alpha was in view from this seated position. The controller reported that he scanned the manoeuvring area prior to issuing landing clearance but did not see the boat. Accordingly, he cleared the aircraft to land and did not include any advisories in the radio transmission. The pilot is ultimately responsible to ensure that the landing area is suitable. After issuing landing clearance, the controller's attention was diverted elsewhere in the moments preceding the collision. He handled one aircraft clearing the control zone to the east, followed by a traffic information update to an aircraft near the Lions Gate Bridge.

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5 F. Hawkins, *Human Factors in Flight*, 1993, pp. 112-113. ISBN 1 85742 135 3

6 Richard H. Wood and Robert W. Sweginnis, *Aircraft Accident Investigation*, p. 116. ISBN 0-9653706-0-7

7 *Human Factors for Aviation, Basic Handbook*, Transport Canada, p. 80. TP 12863

8 F. Hawkins, *Human Factors in Flight*, 1993, p. 116. ISBN 1 85742 135 3

9 *Air Traffic Control, Manual of Operations* (MANOPS), paragraphs 308 and 344.

A large cruise ship was docked on the east side of Canada Place pier that day. When the small boat exited the pier area and turned toward the northwest, it passed behind the stern of the cruise ship. This placed the boat in a position where it could not be seen by the tower controller for several seconds.

The de Havilland DHC-2 Beaver was manufactured in 1958. It was equipped with floats, a three bladed propeller and furnishings which increased the maximum allowable take-off weight from 5090 to 5370 pounds. Total time on the airframe was about 9000 hours, with about 1041 since the last major engine overhaul. To the extent examined, the aircraft had no known deficiencies prior to the collision. The aircraft was examined dockside by company personnel shortly after the collision. No damage was observed and it was returned to service. TSB investigators examined the aircraft out of the water four days after the collision. No damage was found that was attributed to the collision. The pressure-washing-like effect of several water landings conducted after the collision, coupled with scratches and dents accumulated over years of prior use, made it difficult to attribute any particular marks on the floats to the collision.

The boat was a 17.5 foot SeaRay runabout. It had an open cockpit with a covered bow and a windshield in front of the operator and front passenger seats. It was predominantly white, with blue and chrome trim.

Collision impact markings on the boat indicate that the two craft struck each other at an impact angle of about 90° and that the point of contact was between the boat and the aircraft's left float. The boat's windshield frame was flattened and its windshield shattered during the collision. Sharp, slicing type grooves, as well as light green paint transfers, were left on the windshield support structures. The light green colour was the same as that found on the aircraft's floats and was not used anywhere else on the aircraft. A fibreglass area on the boat's starboard sheer strake,[10] measuring about four inches square and 12 inches deep, was cracked during impact. This cracked area was immediately aft and outboard of the boat's throttle quadrant.

Analysis

The diagram at Appendix A illustrates the collision paths of the two objects. Positions for the boat and aircraft are depicted at 25 seconds before impact. Thereafter, speed of the aircraft is depicted as 80 knots for the first 8.33 seconds, 60 knots for the second 8.33 seconds, and 40 knots for the final 8.33 seconds. A uniform speed of 8 knots is depicted for the boat.

The collision occurred within the confines of Area Alpha, but the area's dimensions are not well defined. The two occupants of the boat were not aware that they were transiting Area Alpha. The operator's attention, in the few moments preceding the collision, was not directed toward maintaining a good lookout for landing aircraft and he did not see the floatplane. The operator likely did not have the same appreciation for seaplane traffic as do boaters who frequent the Vancouver harbour area regularly.

From the pilot's perspective, the boat was located within the area of sun glare on the water during the 25-second period prior to impact. To distinguish the light-coloured boat out of the area of glare would have been difficult. In addition, the cabin structures on the left side likely obstructed the pilot's view of the boat at various stages during the approach. These factors accentuated some of the limitations of the human eye. The obstructions or limitations likely would have been overcome by continually moving the eyes and head, thus changing the location of the blind spots. However, in the moments preceding landing it may not be practical for

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[10] Refers to the uppermost portion of a ship's hull, where it joins the deck.

the pilot to be continually changing his eye and head position in an attempt to clear all the blind spots as attention is focussed on flying the aircraft.

The air traffic controller's workload at the time of the collision was assessed as moderate, with normal complexity. When he scanned the area prior to issuing landing clearance, he did not see the boat. Lighting contrast around Canada Place (areas of shadow and bright sunlight) may have degraded his ability to distinguish the boat. When he scanned the manoeuvring area, it is also possible that the boat was shielded from his field of view by the stern of the large cruise ship moored at Canada Place. Using a speed of eight knots for the boat, this would mean that the scan was performed about 34 seconds prior to issuing landing clearance. In the moments preceding the collision, the controller was attending to other aircraft in the area, and he was not watching the landing aircraft.

Findings as to Causes and Contributing Factors

1. The pilot did not see the boat in time to avoid the collision.

2. The pilot's ability to see the boat was reduced by sun glare on the water, masking effects of the aircraft's cabin structures, and limitations of the human eye.

3. The operator of the boat was aware that aircraft operated in the harbour area but was unaware that he was transiting the designated landing area. He did not see the aircraft in time to avoid the collision.

4. The controller did not see the boat and therefore did not recognize the potential for collision.

Other Findings

1. Vancouver Harbour air traffic controllers only control aircraft. They have no control over boats and do not communicate directly with boat operators.

Safety Action Taken

Transport Canada, Civil Aviation's Aerodrome Safety branch has undergone an extensive review of the requirements for the certification of water aerodromes. The regulations and standards associated with the development and certification of water aerodromes have been drafted, and Transport Canada is currently proceeding with the Canadian Aviation Regulation Advisory Council (CARAC) process. It is anticipated that consultations will take place before the summer of 2001. One of the standards that has been proposed for water aerodromes is the requirement to mark all water landing areas with floating marker buoys.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 28 November 2000.

Appendix A - Vancouver Harbour / Collision Diagram