Accident Investigation - Sydney Seaplanes DHC-2 collision with water accident

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ISASI 2023 Presenter: Angus MITCHELL, Chief Commissioner ATSB

Abstract

A 1963 Beaver floatplane fly-dine experience on the Hawkesbury River in Sydney, Australia for a family of international tourists and their pilot ended in tragedy when it crashed into Jerusalem Bay shortly after take-off from Cottage Point on a New Year's Eve afternoon during fine weather conditions. The aircraft had turned inexplicably into Jerusalem Bay (a known box canyon not on the prescribed return route to Sydney Harbour) before stalling in an uncharacteristic steep right turn from low altitude.

On board was a fit, healthy and highly experienced pilot, well respected for his safety ethos. He had over 9,000 floatplane hours and was very familiar with the Hawkesbury River area having conducted over 800 flights between Rose Bay and Cottage Point. The question was, why, if the pilot had experienced some sort of difficulty during the short flight had he entered Jerusalem Bay instead of landing on the expanse of relatively calm water, beneath his aircraft, the Hawkesbury River.

The aircraft submerged in 41ft of water contained no recorded devices. No external data was available since the terrain in the area shielded both radar and radio transmissions. This paper describes the innovative activities undertaken during the ATSB investigation to discover the reason for the unexplained turn and manoeuvre conducted by the experienced pilot that day.

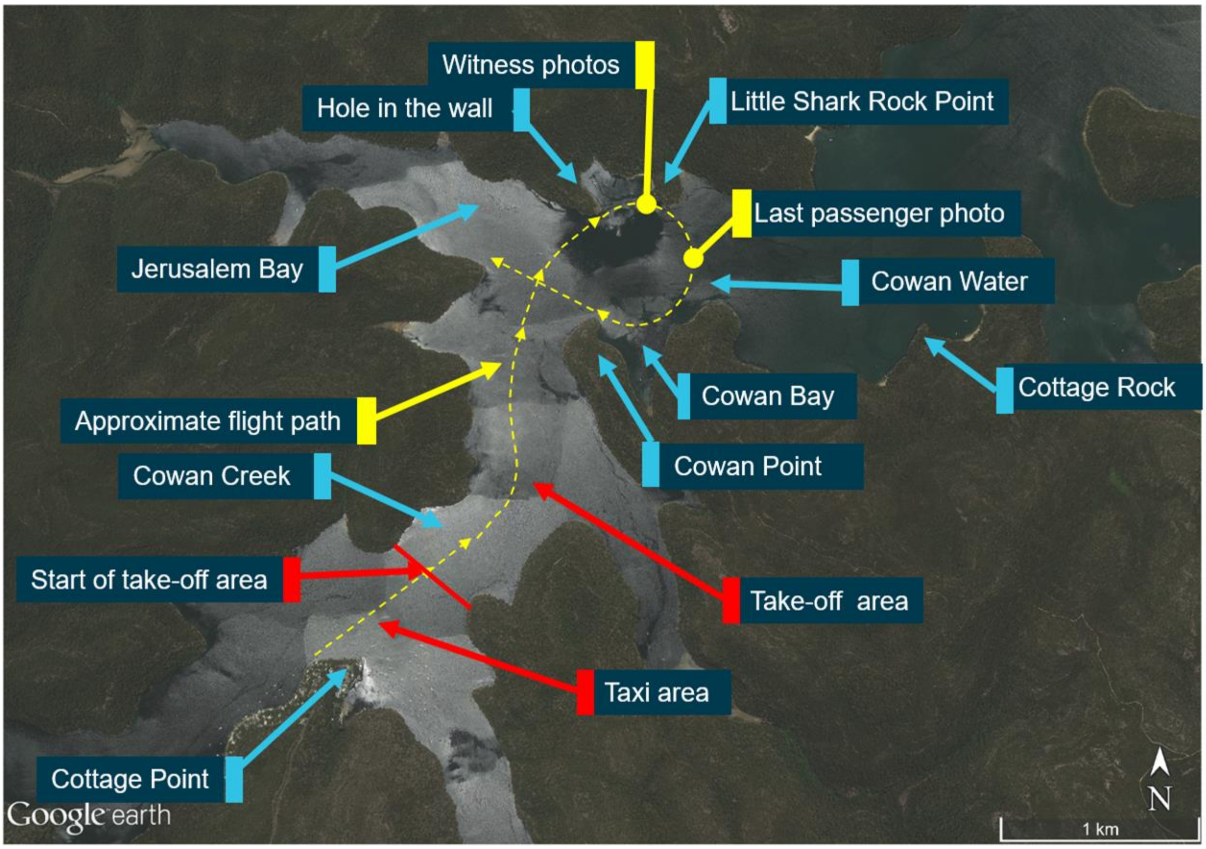
With the world's media watching and limited information available, memory chips from a passenger's water damaged DSLR camera were able to be transplanted onto a donor Compact Flash card resulting in retrieval of all images including 22 images taken during the accident flight. The investigation team used Hollywood CGI software on the images to recreate the flightpath. After searching for the answers with no defining evidence-based conclusions the team submitted their draft final report for review. The draft report explained "what" happened quite accurately due to the abundance of witnesses on the Hawkesbury River and concluded it was quite likely some form of incapacitation, from circumstantial but not conclusive evidence. ATSB were unable to understand "why" these events occurred and were at a loss to provide a suitable and logical explanation to the aviation industry and next-of-kin.

This paper details how the ATSB team were able to discover the "why" of this accident. A breakthrough from a comment by the aviation medical specialist during the internal draft report review and a pathology review resulted in the team diving into the currents that lay beneath this medical result. This involved a re-examination of the wreckage to determine an exposure source and testing on an exemplar aircraft during a period of covid restrictions to test hypotheses. This paper reinforces the value of the peer review system used by the ATSB, use of new technology, storage of aircraft wreckage, pathology liaison and the evidence-based investigation methodology ATSB use to test hypotheses.

What happened

On the afternoon of 31 December 2017, the pilot and five passengers of a de Havilland Canada DHC-2 Beaver floatplane, registered VH-NOO, boarded the aircraft for a return charter flight from Cottage Point to Rose Bay, New South Wales. Shortly after take-off, the aircraft conducted a 270° right turn in Cowan Water and then entered Jerusalem Bay, below the height of the terrain (Figure 1). The aircraft stopped climbing, continued along the bay and then made a very steep right turn. The aircraft's nose then dropped and the aircraft collided with the water. All on board were fatally injured and the aircraft destroyed.

Figure 1: Cottage Point area and approximate initial flight path



Source: ATSB Transport Safety Report AO-2017-118 - Figure 3

What the ATSB found

The ATSB found that some of the circumstances regarding the accident were unexpected given the nature of the operations and the pilot's significant level of experience. Specifically, the aircraft entered a known confined area (Jerusalem Bay) below the height of the terrain, with no need to be operating in the bay; the aircraft did not continue to climb despite being in the climb configuration; the aircraft was capable of turning within the bay, it could have been turned earlier, and there was sufficient distance remaining to land at the position of the steep turn; and a steep turn was performed at low-level and at a bank angle in excess of what was required. It was established that pilot control column and rudder inputs were necessary to travel at least half-way through the final steep turn as observed. However, the propeller was at a 'lower power condition'. The aircraft likely aerodynamically stalled, with insufficient height to effect a recovery before colliding with the water. Further, the front seat passenger was regularly taking photographs, but stopped during the turn in Cowan Water, and it was very likely the middle right passenger was unrestrained at impact.

Toxicology results identified that the pilot and passengers had higher than normal levels of carboxyhaemoglobin in their blood. This was almost certainly due to elevated levels of carbon monoxide (CO) in the aircraft cabin. The ATSB's wreckage examination established that several pre-existing cracks in the exhaust collector ring, very likely released exhaust gas into the engine/accessory bay, which then very likely entered the cabin through holes in the main firewall where three bolts were missing from the magneto access panels. In addition, the examination also found that the in situ bolts used by the operator's external maintenance provider to secure the panels were worn, and were a combination of modified AN3-3A bolts and non-specific bolts (Figure 2).

Figure 2: Magneto access panels, attaching hardware and gaskets

Source: ATSB Transport Safety Report AO-2017-118 - Figure 28

A 27-minute taxi, with the pilot's door ajar, before the passengers boarded likely exacerbated the pilot's elevated carboxyhaemoglobin level. As a result, the pilot would have almost certainly experienced effects such as confusion, visual disturbance and disorientation. Consequently, it was likely that this significantly degraded the pilot's ability to safely operate the aircraft.

The ATSB established that, although not required, the aircraft was fitted with a disposable CO chemical spot detector, which was likely not effective on the accident flight due to sun bleaching. Commonly used in general aviation, these types of detectors have known limitations and can be unreliable at detecting CO in the cabin. Further, they are a passive device that relies on the pilot regularly monitoring the changing colour of the sensor to detect elevated levels of CO. In contrast, electronic active warning CO detectors are designed to attract the pilot's attention through auditory and/or visual alerts, so are more likely to be effective.

While inexpensive and readily available, there was no regulatory requirement from the Civil Aviation Safety Authority for piston-engine aircraft to carry a CO detector with an active warning. Similarly, other international investigation agencies have made safety recommendations to aviation regulators to mandate the carriage of active detectors. However, despite the ongoing threat CO exposure poses to aircraft occupants, these recommendations have not been accepted. Consequently, the ATSB has recommended that the Civil Aviation Safety Authority consider mandating the carriage of active warning CO detectors in piston-engine aircraft with a maximum take-off weight less than 5,700 kg. In addition, while the aircraft carried a passive CO detector, Sydney Seaplanes had no mechanism for monitoring the serviceability of the detectors to their aircraft at the time.

The ATSB has identified a safety issue relating to the lack of requirements to fit recording devices in commercial air transport (passenger-carrying) aircraft with a maximum take-off weight less than 5,700 kg. Given that recent advancements in lightweight recording devices have made this technologically and economically more feasible, the ATSB has recommended that the International Civil Aviation Organization and the Civil Aviation Safety Authority consider mandating the fitment of such devices.

What has been done as a result

In July 2020, the ATSB issued two safety advisory notices to aircraft maintainers, operators and owners of piston-engine aircraft. The first notice reminded maintainers of the importance of conducting detailed inspections of exhaust systems and firewalls, with consideration for potential CO exposure. The second notice strongly encouraged operators and owners to install a CO detector with an active warning to alert pilots to the presence of elevated levels of CO in the cabin. If not provided, pilots were encouraged to carry a personal CO detection and alerting device.

In addition, as a result of this investigation, the Civil Aviation Safety Authority released the related airworthiness bulletin AWB 02-064 in July 2020 and 19 October 2020 Preventing Carbon Monoxide Poisoning in Piston Engine Aircraft.

Related to the consideration of CO exposure, the operator has implemented a range of measures and amended the DHC-2 system of maintenance, including: fitting active electronic CO detectors to their aircraft; monthly CO detector serviceability check; directing its new maintenance provider that following maintenance activities on the engine exhaust system or use of the main firewall access panels, the test for the presence of CO must be conducted.

Safety message

This accident highlights the insidious danger CO exposure poses to aircraft occupants. It reinforces the importance of conducting a thorough inspection of piston-engine exhaust systems and the timely repair or replacement of deteriorated components. In combination with the assured integrity of the firewall, this decreases the possibility of CO entering the cabin.

Further, the use of an attention attracting CO detector provides pilots with the best opportunity to detect CO exposure before it adversely affects their ability to control the aircraft or become incapacitated. Operators and owners of piston-engine aircraft are strongly encouraged to install a CO detector with an active warning to alert pilots to the presence of elevated levels of CO in the cabin. If not provided, pilots are encouraged to carry a personal CO detection and alerting device.

Recording devices have long been recognised as an invaluable tool for investigators in identifying the factors behind an accident, and their contribution to aviation safety is irrefutable. Such systems were generally only fitted and mandated on larger aircraft. However, advancements in technology have led the way for more cost-effective, self-contained image, audio and flight data recording systems accessible to all aircraft. This accident highlights the benefits of having these devices fitted to passenger-carrying aircraft with a maximum take-off weight less than 5,700 kg.

The final investigation report is available at https://www.atsb.gov.au/publications/investigation_reports/2017/aair/ao-2017-118