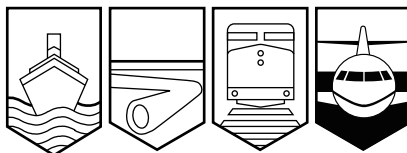


Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT
A01P0165



OVERTURNED ON WATER LANDING

CESSNA U206G C-FHMW
CULTUS LAKE, BRITISH COLUMBIA
18 JULY 2001

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

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Summary

The amphibious, float-equipped Cessna U206G (C-FHMW), serial number U20605459, was flown from the Boundary Bay, British Columbia, aerodrome to the Chilliwack aerodrome on the morning of the accident. At Chilliwack, the pilot-in-command (PIC) picked up another pilot and one passenger for a short demonstration flight to the Cultus Lake area, south of Chilliwack. For that flight, the PIC sat in the right front seat so that the second pilot could fly the aircraft from the left front seat; the passenger sat behind the two pilots. On departure from Chilliwack, the landing-gear handle was selected UP, and the flaps were retracted. During this departure, both pilots were busy visually monitoring the position of other circuit traffic, which included one aircraft that was operating without a radio transmitter. On approach to Cultus Lake, the two pilots discussed the requirement to have the undercarriage retracted for the water landing. Based on the cockpit indications, they concluded that the landing gear was UP. The approach was normal until, on touchdown, the aeroplane decelerated rapidly and overturned, with the landing gear extended. The PIC and the rear passenger escaped with minor injuries. The pilot flying suffered fatal injuries. The accident occurred during daylight in visual meteorological conditions.

Ce rapport est également disponible en français.

Other Factual Information

Aircraft Floats

The accident aircraft was equipped with Wipline 3730 amphibious floats. Amphibious float systems incorporate a retractable landing-gear assembly that allows the aircraft to land on hard-surface runways or water. The Wipline 3730 system is certificated under supplemental type certificate (STC) SA18GL. That STC states that “an FAA approved supplement to the Pilot’s Operating Handbook ... is required to accompany each aeroplane modified by this STC.”

Landing-gear System

The Wipline 3730 landing-gear system is powered by an electrohydraulic power pack in the left-hand float baggage compartment. An emergency handpump is provided to operate the landing gear manually in case of powerpack or electrical failure.

A set of four blue lights (one for each wheel) indicates gear UP position, and a set of four green lights indicates gear DOWN position. Additionally, the pilot can visually check that the landing gear is in the UP position by sighting the shock strut air fitting through a hole in the top of the main gear well and, for the nose gear, sighting a wire indicator protruding above the nose cap.

A red light marked “PUMP ON” advises the pilot that the electrohydraulic powerpack is running during gear transit. The pump shuts off automatically after the desired gear position is attained; a pressure switch cuts off the electrical power to the pump when pressure builds up in the system after the wheels are fully extended or fully retracted. A 25-amp circuit breaker protects the electrical circuit to the pump. The flight manual supplement states that, if the pressure-sensing device fails and the pump does not shut off, the power can be manually turned off by pulling out the landing-gear circuit-breaker. The supplement also states that any faulty pressure-sensing switch should be repaired after the next landing.

Wreckage Examination

The aircraft was floating upside down at the crash site, submerged to the bottom portion of the floats. The landing gear was in its extended position.

After the wreckage was recovered, the landing-gear selector handle was found in the UP position. The landing gear was fully extended and locked in the DOWN position, and the hydraulic-pump circuit-breaker was tripped. The electrical master switch had been turned OFF during the aircraft recovery; therefore, none of the landing-gear lights were illuminated (as found). A switch (below the landing-gear selection handle) that controls the intensity of the landing-gear position-indicator lights was found in the DIM position.

Technical Logbooks

Technical and journey logbooks must be maintained on all certified aircraft in accordance with standards established by the Minister of Transport. These records are essential to safety: they document the aircraft’s maintenance history, predict future maintenance requirements, and allow pilots and maintenance engineers to verify the airworthiness of an aircraft before any flight.

A review of the technical logbooks showed that the most recent 100-hour inspection of the aircraft was done on 21 February 2001. During that inspection, a retraction test of the landing gear was carried out. In the 16 hours of flight time since that inspection, the landing-gear mechanism had had an intermittent problem. After a landing-gear selection, the pump would begin operating, the landing gear would extend and lock down, but the pump would continue to run. The pump would overheat until the protective circuit breaker tripped. A faulty pressure switch was found, and a replacement part had been ordered. In the meantime, the landing-gear assembly had been cleaned and lubricated, and the aircraft had been left in service. The landing gear was reported to have operated normally after that maintenance, until this accident. Although there is no record in the technical logbook or the journey logbook about the maintenance performed on the hydraulic pump pressure switch, the aircraft owner and the pilot-in-command (PIC) of the accident flight were aware of the problem.

Post-accident Testing

Testing of the Wipline 3730 landing-gear system, under the supervision of the TSB, confirmed that the pressure switch for the hydraulic pump was intermittent. During testing, eight cycles of the undercarriage operated normally. On the ninth cycle, the pressure switch malfunctioned at the end of a gear extension sequence, and the circuit breaker tripped. This failure left a cockpit indication of four green lights, gear handle DOWN, and red (pump) light extinguished. Selecting the landing-gear handle UP after this failure gave indications that were the same as those found at the crash site; landing-gear handle UP, four green lights illuminated, and the red pump light extinguished.

During this testing, the gear position could be visually confirmed from the pilot's seat. When the landing gear was DOWN, the shock strut air fitting was *not* visible through the inspection hole in the top of the main gear well. The nose gear wire indicator was *not* protruding above the nose cap. These are two visual warnings that the landing gear is DOWN, despite the selection of the gear handle to UP.

Investigators also noted that the green (gear down) indicators were difficult to see under ambient lighting when the landing-gear lighting switch was set to DIM. Also, because the blue lights were more translucent than the green lights, distinguishing which gear position lights were illuminated was more difficult under ambient lighting conditions when the indicator lights were set to DIM.

Survivability

Both pilots were wearing four-point restraint harnesses that operated on an inertia reel. On impact, the aircraft engine broke free of its mounts and rotated upward, breaking the windscreen. The PIC released his harness and escaped through the broken windscreen. The pilot flying received head injuries and, according to the pathologist's report, died from drowning. The passenger in the second row, left-hand seat, was restrained by a lap strap and, after the accident, escaped from the aircraft through the left front window.

Checklists

Checklists are used as an aid to reduce human error and are designed so that a flight crew member need not rely on memory for routine checks, such as before and during engine start, before take-off, before landing, and for some engine and system malfunctions. Checklists form

the foundation of pilot standardization and are essential for cockpit safety. The improper use or the non-use of the normal checklist by flight crews is sometimes cited as the probable cause or at least a contributing factor to aircraft accidents.

Errors during psychomotor or cognitive tasks are normal and occur about 1 in 100 attempts at a simple repetitive task. Under certain conditions, human reliability can improve by several orders of magnitude. An error rate of 1 in 1000 is usually considered acceptable. As a comparison, and to put this human error rate in perspective, the British Civil Aviation Authority requires that automatic landing equipment not suffer a catastrophic failure more than once in 10 million landings.¹

Canadian Aviation Regulation 602.60 requires that all power-driven aircraft be equipped with checklists or placards that enable the aircraft to be operated in accordance with the limitations specified in the aircraft flight manual, aircraft operating manual, pilot's operating handbook, or any equivalent document provided by the manufacturer. The pilot's operating handbook for the Cessna U206G provides pilots with detailed checklists, as required by the above regulation. One such check, entitled "Before Starting Engine", requires the pilot to ensure that all circuit breakers are IN.

An aircraft modified by an STC may require certain additional checks. An amphibious float system requires additional checks of the landing-gear position and the function of the landing-gear system. Where required, these checks are published in a flight manual supplement for the aircraft or placards are added to the aircraft. Aircraft owners/operators are not formally required to integrate information from the flight manual supplement into the original aircraft checklist.

Despite the aircraft modification (the addition of Wipline 3730 floats), no checklists, flight manuals, or flight manual supplements were found in the aircraft. The only available checklist on board the aircraft was the mnemonic GUMP, which was affixed to a label and stuck onto the left V-brace member. That mnemonic is often taught as a simplified check to use before landing and serves to remind the pilot to check the *Gas, Undercarriage, Mixture, and Propeller*.

Pilot Qualifications

The PIC held a valid airline transport pilot licence and was qualified to operate single- and multi-engine land and sea aircraft and numerous helicopter types. He had been flying on fixed-wing aircraft since 1980 and had over 21 000 flying hours. His medical category was FIT, Category 1, with a restriction that glasses must be worn.

The other pilot held a valid commercial pilot licence (helicopter) and a private pilot licence (aeroplane). He was qualified to fly single-engine landplanes and seaplanes and had approximately 9000 flying hours. His medical category was FIT, Category 1, with a restriction that glasses must be available.

Both pilots met the currency requirements for a private flight and both were experienced operating amphibious aircraft. However, in general terms, neither of the involved pilots relied on formal checklist usage during seaplane operations.

¹ Frank H. Hawkins, *Human Factors in Flight*, 2nd edition, England, 1993, p. 27.

Analysis

Based on a review of the sequence of events, it is apparent that the landing-gear hydraulic-pump circuit-breaker tripped before the last take-off from Chilliwack. Based on the system configuration at the crash site, the circuit breaker most likely tripped after the undercarriage had been extended for landing at Chilliwack.

On departure from Chilliwack, the pilot moved the landing-gear selector to UP. Because the hydraulic-pump circuit-breaker had previously tripped, the hydraulic pump did not operate, and the landing gear remained in its extended position. A pre-flight inspection performed in accordance with the aircraft flight manual would likely have identified the tripped circuit breaker, and it could have been reset before engine start. When the landing gear was selected UP after take-off, both pilots were concentrating on visually monitoring the local traffic, and neither pilot noted that the landing gear had failed to retract. Additionally, the landing-gear indicator lighting system was in the DIM position, thereby reducing the conspicuity of the indicator lights.

Other than a system description, there are no specific checklist items in the Wipline flight manual supplement requiring a pilot to confirm that the landing gear has properly retracted after a runway take-off. However, the Wipline STC does require the addition of certain placards to the aircraft panels. One such placard is placed adjacent to the landing-gear control handle and indicates "UP - WATER" and "DOWN - LAND". In this accident, the placarding of the aircraft panel did not provide an effective defence: the landing-gear handle had been selected to the "UP - WATER" position, but the wheels remained extended. A more detailed checklist on the operation of the landing-gear system, rather than an elemental system description, might have reduced the risk of this accident occurring. There is currently no requirement to provide such a checklist or to integrate the items required by the STC into the original aircraft manufacturer's checklist procedures.

During their approach to Cultus Lake, the two qualified pilots discussed the requirement to have the undercarriage retracted for the water landing. They did not, however, confirm the gear position using all of the available warning systems:

- The pilots did not note that the four illuminated landing-gear position lights were green rather than blue (as described in the flight manual supplement).
- The pilots failed to note that the illuminated lights did not correspond to the gear handle position. Although the flight manual supplement adequately describes the landing-gear system, the relationship between the lights and the handle position may not be clear to all pilots because the placards are next to the landing-gear handle rather than near the indicator lights.
- The pilots did not use the external visual indicators of the landing-gear configuration.

The DIM switch setting might have adversely affected the pilots' ability to distinguish which set of landing-gear lights was illuminated.

The pilots would have more likely noticed the discrepancy between the landing-gear configuration and the cockpit indications had they properly used a checklist or the flight manual supplement or better understood all the warning systems associated with the landing gear.

Although the pilot-in-command of this flight was aware of a previous problem with the landing-gear system, the aircraft's journey and technical logbooks had not been annotated to document the problem or the resultant maintenance activity. Without such documentation, any other pilots who subsequently fly the aircraft would be unaware of the intermittent problem that had been identified with the landing-gear system and would therefore be placed at increased risk.

Findings as to Causes and Contributing Factors

1. A pressure switch in the landing-gear circuit failed on arrival at Chilliwack, causing the hydraulic pump to continue to run and the landing-gear circuit-breaker to trip.
2. The aircraft pre-start check was incomplete: the pilots did not ensure that all circuit breakers were IN before engine start.
3. The pilot raised the landing-gear selector to the UP position on departure from Chilliwack. However, because the circuit breaker had tripped, the pump did not operate, and the landing gear remained in its extended position.
4. The pilots failed to visually confirm the position of the landing gear before landing on the water and did not note that the landing-gear indicators were showing that the gear was DOWN.
5. The aircraft landed on water with the landing gear extended, causing the aircraft to overturn.
6. The aircraft was being operated with a faulty landing-gear pressure switch. The pilot was aware of this defect.

Findings As To Risk

1. The aircraft flight manual and its associated checklists were not available on board the aircraft and were therefore not used by the crew.
2. Setting the landing-gear lights to DIM increases the difficulty of distinguishing which set of lights is illuminated when operating in daylight conditions.
3. The aircraft's journey and technical logbooks had not been annotated to document the landing gear problem or the resultant maintenance activity. Therefore, pilots who subsequently fly the aircraft could be unaware of the landing-gear system problem and would be at increased risk.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 26 June 2002.