Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A06O0186

COLLISION WITH TERRAIN

CESSNA 180H N720CS
CORDINGLEY LAKE, ONTARIO
19 JULY 2006

Canada

Aviation Investigation Report

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Summary

The float-equipped Cessna 180H (registration N720CS, serial number 18052165) took off from Cordingley Lake, Ontario, at 0905 eastern daylight time on a local flight with the pilot and two passengers on board. The owner of the aircraft, a licensed pilot, occupied the right rear seat, and a second passenger, also a licensed pilot, was in the right front seat. After completing the engine run-up checks, the take-off run was commenced without backtracking. After liftoff, the aircraft reached tree-top height but would not continue to climb or accelerate. As the aircraft crossed the shoreline and made initial contact with the tops of trees, full flaps were selected and the aircraft nose was raised so that the floats would absorb the impact. The floats struck the trees and the aircraft pitched nose-down and struck the ground in a near-vertical attitude. The three occupants received minor injuries. A small, post-impact, fuel-fed fire occurred forward of the firewall; the fire did not spread beyond that localized area.

Ce rapport est également disponible en français.

Other Factual Information

History of the Flight

The weather, as locally reported, was as follows: wind from the south at 10 to 12 knots, the sky mostly clear, and the temperature approximately 20°C. The lake surface, which was somewhat sheltered by the surrounding trees, was reported to be calm.

The aircraft's floats were pumped out as part of the pre-flight checks. The aircraft was taxied to the north end of the lake and turned into wind for run-up checks of magneto and propeller operations. The aircraft travelled approximately 1000 feet during these checks. At 0905 eastern daylight time [1], it began its take-off run with approximately 4000 feet remaining to the shoreline (see Appendix A - Aircraft Take-off Path). Flap setting was 20°. The aircraft came up on the step normally. The right float was rolled off the water; then it settled back. The right float was rolled off again and the aircraft became airborne at a speed of approximately 60 mph. The actual water run was approximately 2000 feet.

After the aircraft was airborne, it accelerated to about 65 mph and climbed to about tree-top height. It then stopped accelerating or climbing and the airspeed decreased to about 60 mph. The aircraft was turned 20° to 30° to the left to take advantage of lower terrain in that direction. The distance remaining to the shoreline was considered to be too short to permit a safe landing straight ahead. As the aircraft crossed the shoreline and made initial contact with the tops of trees, full flap (40°) was lowered and the controls were pulled aft in an attempt to slow the aircraft and cushion the impact by striking with the bottom of the floats first. The engine remained at full power.

Accident Aircraft

N720CS, a Cessna 180H, was equipped with Canadian Aircraft Products (CAP) series 3000D floats. It was powered by a Teledyne Continental O-470-R normally-aspirated, reciprocating engine and was fitted with a 78-inch, three-blade Hartzell propeller. The CAP series 3000D floats were approved under supplemental type certificate (STC) SA1749WE. The three-blade propeller was approved under STC SA00852AT.

The aircraft was also equipped with bubble door windows (STC SA00897CH) and a short take-off and landing kit (STC SA967CE). During the investigation, these two STCs were assessed as having negligible effect on the performance of the aircraft.

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[1] All times are in eastern daylight time (coordinated universal time minus four hours).

All STCs associated with N720CS contained a standard limitation and condition as follows:

> The approval of this change in the type design applies basically to the aircraft models listed on the relevant FAA approved master eligibility list and should not be extended to other specific models of these airplanes on which other previously approved modifications are incorporated, unless it is determined that the interrelationship will introduce no adverse effect upon the airworthiness of that aircraft.

For the accident flight, the aircraft's take-off weight was calculated to be 2935 pounds and the centre of gravity was calculated to be at 42.1 inches aft of the datum. Records indicate that it was serviced and maintained in accordance with existing directives. There were no reports of aircraft discrepancies prior to or during the flight. There were no discrepancies with the flight control system or indications that the engine was performing abnormally.

The owner reported satisfactory performance of the aircraft when the three-blade propeller was installed and it was in a land-plane configuration. However, when the floats were installed, there was a loss of performance that was subjectively characterized as being equivalent to carrying an extra 300-pound load.

The accident aircraft was equipped with lap belts and shoulder harnesses for the two front seats, and lap belts for the two rear seats. The pilot and front-seat passenger wore the lap belts and shoulder harnesses. Each received a minor injury to the knee adjacent to the pedestal, but neither had face or head injuries. The owner, in the rear seat, had the lap belt fastened and received minor facial injuries. They were able to walk to the shoreline where they were rescued by a person who had observed the crash.

Aircraft Certification

The Cessna 180H aircraft was issued with type certificate number 5A6 by the United States Civil Aeronautics Board under the authority of Civil Air Regulation, part 3. The FAA has the authority to issue STCs under the provisions of Federal Aviation Regulation, part 21. Any person who alters a product by introducing a major change in type design not great enough to require a new application for a type certificate under section 21.19 shall apply to the Administrator for a supplemental type certificate, except that the holder of a type certificate for the product may apply for amendment of the original type certificate.

The type certificate data sheet (TCDS) for the Cessna 180H indicates that the Continental O-470-R is one of two different engine models approved for the 180H. The TCDS also lists ten different two-blade propellers of diameters varying from 82 inches to 88 inches, six of which have no limitations associated and four of which are applicable only to the O-470-R engine. Two additional propellers are listed for aircraft that have been reworked in accordance with specific Cessna Service Kits that were not applicable to the accident aircraft. The TCDS lists one landplane version, two floatplane versions, and one amphibious float version of the model 180H.

There was no requirement in the certification criteria for an approved aircraft flight manual (AFM). Cessna provided an owner's manual (OM) for the model 180H which depicts only the landplane equipped with wheels. This OM does not cover float or ski configurations, but states that OM supplements are provided to cover operation of other optional equipment. The OM has an operational data section with performance charts for the landplane, but the performance figures do not indicate that they are for a particular engine or propeller.

There is a table on the inside front cover of the OM entitled "Performance-specifications". This table lists the engine as a Continental O-470-R and the propeller as an 82-inch diameter constant-speed. There is nothing elsewhere in the OM that addresses engine-propeller combinations. Specifically, the operating limitations section has no restrictions that prohibit any engine-propeller combination.

In the TCDS, there are no restrictions as to which propeller can be installed on any of the versions of the aircraft. Cessna provided an OM supplement [2] for the model 180 equipped as a floatplane, amphibian, or skiplane. This supplement is applicable to the floats that are listed in the TCDS, one of which is the Edo model 249A-2870. The operational data section of this supplement has performance charts for the model 180 floatplane.

The only propeller installed by Cessna for the factory-delivered float installation is the 88-inch, two-blade propeller. The only mention of engine or propeller is inside the front cover of the OM supplement in the "Performance-Specifications" table where it lists the engine as a Continental O-470-R and the propeller as 88-inch diameter constant-speed. There is nothing elsewhere in the floatplane OM supplement that addresses engine-propeller combinations. The operating limitations section has no restrictions that prohibit any engine-propeller combination.

According to the Cessna OM supplement performance charts, for the gross weight, lake elevation, and atmospheric conditions at the time of the accident, the water run distance required for take-off was 1050 feet, and the total distance required to clear a 50-foot obstacle was 1800 feet.

STC Integration and Performance Implications

CAP Series 3000D STC

The CAP series 3000D floats were installed under an STC and therefore are not mentioned in the Cessna OM supplement for floatplanes. The approved AFM supplement for the CAP series 3000D float states that performance equals or exceeds that with the Edo model 249A-2870 floats, which are similar to the model 249A-2870 floats that are listed in the Cessna floatplane OM supplement.

As originally written and approved in 1968, the CAP series 3000D STC specified a maximum gross weight of 2820 pounds for the Cessna model 180H seaplane, the same maximum gross weight as stated in the Cessna OM supplement for the floatplane on Edo model 249A-2870 floats. The CAP series 3000D STC was later amended to provide a gross weight limit of

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[2] Owner's manual supplement, 1969 Cessna Skywagon 180 floatplane, amphibian, and skiplane.

2950 pounds and an approved centre of gravity range of 38.8 inches to 43.9 inches aft of the datum. The CAP series 3000D STC stated that the performance of the aircraft with CAP series 3000D floats was equal to or better than that with Edo model 249A-2870 floats. The Cessna 180 OM supplement for the floatplane provides performance charts up to a gross weight of 2950 pounds, but contains a note that the maximum gross weight for the Edo model 249A-2870 floats is 2820 pounds. The investigation was unable to determine what performance tests or engineering analyses were carried out to substantiate the gross weight increase for the CAP series 3000D floats.

Three-Blade Propeller STC

The three-blade propeller was installed under an STC issued to the former Bonaire Aviation Company. The STC is now owned by Hartzell Propeller Inc. The STC has no limitation as to applicability to floatplane configurations. The associated installation instructions referred to both land and sea configurations for changing markings on the tachometer. The associated AFM supplement states that original aircraft placards apply to information that is not addressed in the supplement. In operating limitations, the AFM supplement presents the same tachometer markings as the installation instructions, but refers to land and amphibian configurations rather than land and sea.

In the operational data section, the AFM supplement states that "performance…equals or exceeds the performance with the original engine or propeller." Supporting documentation for the approval of the STC indicates that this statement was based on a comparison of the efficiency of the three-blade, 78-inch propeller with various two-blade, 82-inch propellers that were approved for the Cessna 180; it did not compare the three-blade, 78-inch propeller with two-blade, 88-inch propellers. Hartzell Propeller Inc. analytically compared the three-blade, 78-inch propeller and a two-blade, 88-inch propeller and predicted a loss of about 3% thrust at take-off conditions. Analysis by the FAA estimated the following performance effects:

- Climb rate during initial climb reduced by 50 feet per minute;
- Take-off water run increased by 50 feet;
- Air distance from lift-off to a height of 50 feet increased by approximately 150 feet; and
- Total take-off distance to clear a 50-foot obstacle increased by approximately 200 feet or about 10%.

The three-blade, 78-inch propeller would not provide performance equivalent to the two-blade, 88-inch propeller that was the basis for the floatplane version. Therefore, a floatplane equipped with the three-blade, 78-inch propeller could not achieve the performance specifications depicted in the Cessna floatplane supplement.

According to the three-blade propeller STC, engineering analysis, supported by tests at representative speeds, had demonstrated that the three-blade propeller provided performance equal to or better than approved performance charts in the Cessna 180 OM [3]. The OM performance charts cover a wide range of engine and propeller combinations that are approved

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[3] Owner's manual, 1970 Cessna Skywagon 180.

by the FAA for installation in the Cessna 180. As part of this investigation, propeller manufacturers were contacted and they indicated that some combinations, including longer-diameter, two-blade propellers, likely provide noticeably better performance than shown on the charts.

Take-Off Procedure

According to the Cessna floatplane supplement, the recommended take-off procedure is to use 20° flap, accelerate and lift-off at 50 to 60 mph, climb at 65 mph to clear obstacles, and retract the flaps slowly after reaching a safe altitude and airspeed. If lift-off is difficult due to high lake elevation or glassy water, the supplement recommends rolling one float out of the water first.

Through experience with the three-blade propeller on floats, the owner's usual take-off technique on N720CS was to roll one float off at 55 mph, raise the flaps to 10° as soon as airborne, and keep the nose down to accelerate to 80 mph before beginning to climb.

Pilot Experience

The pilot held a private pilot's licence valid for single-engine land and seaplanes. He had approximately 500 hours of flying time, most of which were on a float-equipped Cessna 185 that he owned. He had three hours on the Cessna 180, including a check flight flown the previous day with the owner of N720CS. The check flight was completed in another Cessna 180 that also belonged to the owner of N720CS. The aircraft used for the check flight differed in that it had an 88-inch McCauley two-blade propeller, Edo model 2960 floats, standard windows, and no short take-off and landing kit.

For the check flight on the previous day, the take-off weight of the aircraft was lighter, as there were only two persons on board. The fuel load was similar and there was less cargo. The take-off was performed with 20° of flap in accordance with the AFM float supplement. The aircraft flew off without needing to be rolled onto one float, accelerated to 80 mph, and climbed. Flaps were retracted while climbing through 200 feet. This take-off procedure is similar to that used by the pilot in his own Cessna 185, except that he uses only 10° of flap in the Cessna 185 during the water run. The pilot was not informed about the need (on the accident aircraft) to retract the flaps to 10° in order to accelerate and climb.

Analysis

There was no indication that environmental conditions or a mechanical failure were factors in this accident. Taking into account the distance used for the before-take-off checks, the distance available to clear the trees was considerably in excess of that predicted by the floatplane supplement for take-off and obstacle clearance. Therefore, the investigation focused on performance of the aircraft and pilot technique.

When the propeller and floats were installed, neither of the supplemental type certificates (STCs) contained information that indicated a performance penalty. Each had a standard disclaimer that if other modifications were already incorporated, the installer should determine that the interrelationship between the new modification and existing modifications would introduce no adverse effect on the airworthiness of the aircraft. There was no physical incompatibility between the STCs and neither indicated any operating or performance limitations. The investigation concluded that the combination of the two STCs was not a significant factor in this accident. Rather, the absence of information regarding the degradation of take-off performance for the model 180H floatplane incorporating a three-blade propeller, in accordance with STC SA00852AT, resulted in both the installer of the STC and the aircraft owner being unaware that installation of the three-blade propeller would result in a reduction of take-off capability.

Poorer than expected performance had been noted by the owner after the three-blade propeller was installed and the aircraft was changed from wheel to float configuration. The only propeller approved by Cessna for the floatplane is the 88-inch, two-blade propeller. This is not readily apparent in the floatplane supplement where the 88-inch propeller is mentioned only in the performance specification table inside the cover. Also, the floatplane supplement contains no limitations as to minimum propeller diameter and the aircraft type certificate data sheet (TCDS) does not distinguish between propellers approved for land and float configurations.

The STC was approved on the basis of equivalency between the three-blade, 78-inch propeller and the two-blade, 82-inch propeller which was the basis for certification of the 180H landplane. The three-blade, 78-inch propeller would not provide performance equivalent to the two-blade, 88-inch propeller that was the basis for the floatplane version; therefore, a floatplane equipped with the three-blade, 78-inch propeller could not achieve the performance specifications depicted in the Cessna floatplane supplement. This was not appreciated either by the Federal Aviation Administration (FAA) or by Bonaire Aviation Company, the original STC applicant. As a result, the STC was approved for land and floatplane configurations of the Cessna 180 without indicating that there was a performance penalty associated with the floatplane configuration.

The investigation also noted that the Canadian Aircraft Products (CAP) series 3000D float STC, in its performance statement for the Cessna 180, referred to a slightly different model of Edo float than the model that was the basis for the performance charts in the Cessna owner's manual supplement for the floatplane. It also allowed for operation at a higher gross weight than was provided for by the Cessna performance charts for the equivalent float. It was not possible to trace the supporting material for approval of this STC, therefore it could not be determined what performance testing had actually been conducted for the CAP series 3000D floats at the higher gross weight. The STC does not provide performance charts for operation at higher gross weights than those published for the floats that they replace.

The owner devised a work-around for the performance degradation by mentally acknowledging an equivalent weight penalty and adopting the non-standard procedure of raising the flaps to 10° as soon as airborne to facilitate acceleration and climb. This information was not passed on to the pilot prior to the accident flight.

The pilot, unaware of the idiosyncrasies of N720CS, relied on his previous experience and that of the previous day's check flight to make judgments during the take-off that led to the accident. The owner, who was sitting in the back seat, could not adequately monitor the take-off and provide appropriate advice to the pilot. By the time the gravity of the situation was recognized, the aircraft was too close to the shoreline and could not avoid hitting the trees.

A contributing factor to the accident was that the pilot did not use the full length of the lake for the take-off. Based on previous experience, a take-off could be safely conducted in the length of run available on the lake. When the expected performance was not achieved, the reduced length shortened the time available to recognize the situation and respond accordingly.

The pilot's decision to lower full flap while maintaining full power after initial contact with the tops of trees was intended to reduce the severity of the impact. However, full-flap stall speed is not significantly less than that at 20° flap. Full flap results in a lower nose attitude at the stall and it causes a nose-down trim change, which may have an effect opposite to the pilot's intent. In addition, the drag increase with full flap exacerbates the aircraft performance degradation and eliminates any possibility of recovery. The high power setting of the aircraft on contact with the trees increased the risk of damage and post-impact fire.

Findings as to Causes and Contributing Factors

1. In approving the supplemental type certificate for the three-blade propeller, the Federal Aviation Administration did not recognize that the performance analysis provided by the applicant was not valid for the floatplane version or that there would be an associated performance reduction.

2. As a result of the performance reduction, the aircraft could not achieve the published take-off and climb performance specifications; this contributed to its inability to clear the obstacles at the end of the lake.

3. The pilot was not familiar with the take-off procedure developed by the owner of the aircraft to compensate for the performance degradation.

4. During the take-off, the owner occupied a rear seat where he could not adequately monitor the take-off and provide appropriate advice to the pilot.

5. The pilot did not use the full length of the lake for take-off, reducing the time available to assess the aircraft's performance and limiting the options available when the expected performance was not achieved.

Findings as to Risk

1. Maintaining full power after the aircraft was committed to descending into the trees increased the risk of damage and post-impact fire.

2. The type certificate data sheet for the Cessna 180 indicates that a wide variety of propellers may be installed on the Cessna 180 but does not define which propellers are approved only for the landplane and therefore are not suitable for the floatplane. As a result, maintenance organizations and aircraft owners may unknowingly install propellers that do not satisfy the airworthiness standards for the aircraft.

3. The 1969 Cessna 180 floatplane, amphibian, and skiplane owner's manual supplement does not indicate either in the limitations section or the required equipment section that the airworthiness standards for the aircraft require that an 88-inch propeller be installed. As a result, pilots and operators will be unaware that shorter-diameter propellers are not approved for use on the floatplane version of the aircraft.

4. Supplemental type certificate SA1749WE, for the installation of Canadian Aircraft Products series 3000D floats, approves the floats for operation at higher gross weight than the floats they replace, but does not provide performance operating data at the higher gross weight.

Safety Action Taken

Hartzell Propeller Inc. is studying the effect on aircraft performance of the propellers listed on the Cessna 180 type certificate data sheets. If flight tests are required, it will present the results to the Federal Aviation Administration (FAA). It will also keep the Transportation Safety Board advised of its test progress and discussions with the FAA.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 03 April 2008.

Appendix A – Aircraft Take-off Path