

Transportation Safety Board  
of Canada



Bureau de la sécurité des transports  
du Canada

## AVIATION INVESTIGATION REPORT

A07W0099



**LOAD SHIFT/LOSS OF CONTROL ON TAKE-OFF**

**BLACK SHEEP AVIATION AND CATTLE COMPANY**

**de HAVILLAND DHC-3T C-GZCW**

**MAYO, YUKON**

**02 JUNE 2007**

**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 Black Sheep Aviation and Cattle Company de Havilland DHC-3T Turbo Otter (registration C-GZCW, serial number 447) had been loaded with a cargo of lumber at Mayo, Yukon. The aircraft was taxied to the threshold of Runway 06 and the pilot began the take-off roll at 1755 Pacific daylight time. At lift-off, the aircraft entered an extreme nose-up attitude and began to rotate to the right. Shortly thereafter, the aircraft struck the airport ramp. The pilot, who was the sole occupant of the aircraft, was fatally injured. A small post-impact fire was extinguished by first responders.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

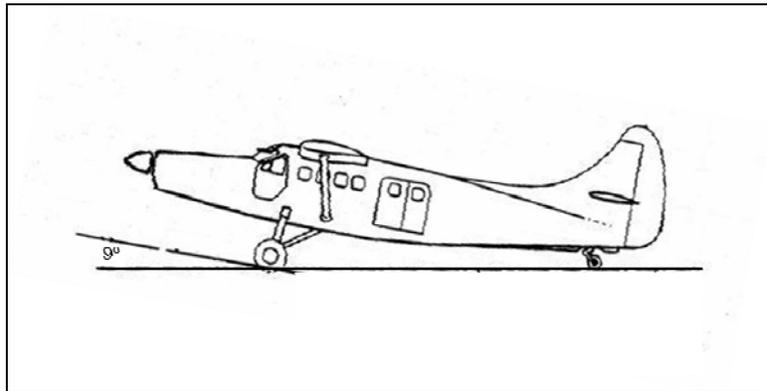
Examination of the engine and propeller at the accident scene indicated that high power was being developed at impact. It was determined that the aircraft's flaps were configured for take-off. Control continuity and location of the elevator trim jack indicated that the aircraft was trimmed for a full nose-down attitude. It could not be determined whether the trim was applied during the take-off roll to assist the pilot in getting the tail of the aircraft to become airborne, or if the nose-down trim was applied after take-off in an attempt to lower the nose to recover from the extreme pitch-up attitude.

The weather observation at 1800 Pacific daylight time<sup>1</sup> was as follows: wind 070°T at 2 knots; visibility 20 statute miles (sm) with showers in the vicinity; clouds 5000 feet scattered, 9000 feet broken, 23 000 feet overcast; temperature 21°C; dew point 5°C; altimeter setting 29.91 inches of mercury.

The pilot was licensed and endorsed according to existing regulations and held a commercial pilot licence (aeroplane) with a seaplane rating. He had extensive experience on Piper PA18 and Cessna 185 aircraft, having accumulated approximately 4000 hours of flight time in these types. The pilot received his initial company training on the occurrence aircraft in March 2007. At the time of the occurrence, the pilot had accumulated approximately 202 hours on type, of which 27 hours were under dual instruction and supervision of a company training pilot.

Black Sheep Aviation and Cattle Company is a CARs (*Canadian Aviation Regulations*) 702 (Aerial Work) and 703 (Air Taxi) organization based in Whitehorse, Yukon. At the time of the occurrence, the company was operating the occurrence aircraft out of a sub-base in Mayo, Yukon.

The occurrence aircraft was a de Havilland DHC-3T Turbo Otter manufactured in 1965 (see Figure 1). The aircraft had undergone a Texas Turbine conversion in March 2007 and was equipped with a Garrett TPE 331-10R-511L engine and a Hartzell HC-B4TN-5NL propeller. The aircraft was certified to a maximum take-off weight of 8000 pounds under Supplemental Type Certificate



**Figure 1.** de Havilland DHC-3T Turbo Otter

SA02-15. C-GZCW had accumulated approximately 197 hours since the conversion, and had undergone a 100-hour inspection on 24 May 2007. The aircraft had logged 24 hours since the last inspection. At departure, the aircraft had three hours of fuel on board.

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<sup>1</sup> All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

C-GZCW was loaded with a mixture of rough and finished lumber weighing approximately 2213 pounds. The cargo was composed of six 16-foot rough beams measuring 7 ½ inches by 7 ½ inches, a selection of 16-foot rough lumber, and a selection of 10-, 12- and 14-foot finished boards. The lumber was loaded so that all the boards were flush with the front of the cabin. At rest, the aircraft described a 9° nose-up attitude, resulting in the cargo being loaded in an “uphill” manner while the aircraft was on the ground (see Figure 1). Before the occurrence flight, several loads of lumber had been hauled to the same destination.

The load was secured with a single one-inch cargo strap that was placed over the lumber. The strap was fastened to tie-down points located ahead of the rear cargo doors. The floor of the aircraft was plywood.

An operational flight plan was not found at the accident scene, and it could not be determined if a weight and balance calculation had been completed before the departure of the flight. The most recent weight and balance report for C-GZCW was calculated on 15 March 2007. TSB investigators calculated the aircraft weight and balance using fuel load and distribution information and average lumber weights. The take-off weight of the aircraft was calculated to be 7512 pounds, 488 pounds under the maximum take-off weight. The maximum aft centre of gravity (CG) limit was determined to be 152.2 inches. The CG of the occurrence aircraft was calculated to be 154.8 inches aft of the datum, 2.6 inches behind the rearward limit.

With the CG at or behind the center of pressure, a conventional airplane is unstable in pitch. Since there is no automatic restoring force, when a small bump or control input starts the nose up, the nose continues to pitch up more and more unless the pilot acts. This can happen very quickly, and it is possible the force required to push the nose back down could exceed the aerodynamic capability of the elevators...An aft CG makes it much easier to enter an accidental stall...Recovery may be impossible.<sup>2</sup>

Section 703.37(1) of the CARs states, in part, that “no person shall operate an aircraft unless, during every phase of the flight, the load restrictions, weight and centre of gravity of the aircraft conform to the limitations specified in the aircraft flight manual.”

The company operations manual also provided instructions to pilots concerning the requirement for completing an operational flight plan with weight and balance, as well as the importance of operating the aircraft within the approved CG limitations.

In 2004, the North American motor carrier industry adopted National Safety Code Standard 10 – Cargo Securement. During the development of the standard, the trucking industry and government regulators recognized that there were a number of variables that influenced cargo security. These were identified as anchor points, tie-downs, friction, and

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<sup>2</sup> Jeppesen Sanderson, Inc., *Private Pilot Manual*, Englewood, Colorado, 1997, pp. 8-45.

blocking. Friction that is present between the cargo and the deck does play a role in preventing cargo movement. However, it remains inherently unreliable and should never be considered the sole means of cargo securement.<sup>3</sup>

There are several documented accidents in the TSB database where the cargo has shifted and resulted in loss of control accidents.

- A85Q0057 – Two fatalities. A float-equipped Cessna 305C stalled with an aft CG and unsecured load.
- A00C0059 – Two fatalities. A DC-3 lost control during a go-around procedure. The aircraft had CG aft of the rear limit, and the cargo was inadequately secured.
- A01W0239 – Three fatalities. A Beech UC45-J lost control after take-off with an inadequately secured load of moose meat.
- A06P0095 – One serious injury. A Cessna 185B aft CG aggravated by a possible load shift in turbulent conditions led to a loss of control.

## *Analysis*

The aircraft was loaded in a manner that resulted in the CG being aft of the rearward limit. The smooth surface of the finished lumber provided less friction against the plywood cabin floor. The cargo was only secured with one lateral strap and it is likely that the shorter finished boards moved aft during the taxi and take-off roll, which would result in a significant rearward shift of the CG.

The rearward shift of the CG during the taxi and take-off roll resulted in C-GZCW pitching nose up, stalling and entering an incipient spin from which the pilot was not able to recover.

## *Findings as to Causes and Contributing Factors*

1. The aircraft was loaded in a manner that resulted in the centre of gravity being aft of the rearward limit.
2. Because the cargo was not properly secured, it shifted towards the rear of the aircraft, resulting in the centre of gravity moving further aft, causing the aircraft to pitch up and stall.

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<sup>3</sup> Office of Motor Carrier Research and Standards, *Technical Briefing*, Washington, D.C., 1998.

## *Safety Action*

On 30 August 2007, the TSB issued Safety Advisory A07W0099-D1-A1 (*Inadequate Cargo Restraint*) to Transport Canada. The safety advisory suggested that Transport Canada may wish to inform industry of the significance of load shifting on aircraft performance and the need to effectively secure cargo in order to reduce the risk of in-flight load shift.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 December 2007.*