

Transportation Safety Board  
of Canada



Bureau de la sécurité des transports  
du Canada

## AVIATION INVESTIGATION REPORT

A05W0127



### INCORRECT LOADING / CENTRE OF GRAVITY

AIR TINDI LTD.

DE HAVILLAND DHC-3T C-FXUY

YELLOWKNIFE - EAST BAY, NORTHWEST TERRITORIES

24 JUNE 2005

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 Occurrence Report

### Incorrect Loading / Centre of Gravity

Air Tindi Ltd.

de Havilland DHC-3T C-FXUY

Yellowknife - East Bay, Northwest Territories

24 June 2005

Report Number A05W0127

### *Summary*

The Air Tindi Ltd. de Havilland DHC-3T (Turbo) Otter (registration C-FXUY, serial number 142) water taxied from the Air Tindi dock at Yellowknife, Northwest Territories, for a charter flight to Blachford Lake. The aircraft was loaded with two crew members, seven passengers, and 840 pounds of cargo. Before the flight, the pilot conducted a pre-flight passenger briefing, which included information about the location of life preservers and emergency exits.

During the take-off run, at about 1912 mountain daylight time, the aircraft performed normally. It became airborne at about 55 mph, which is lower than the normal take-off speed of 60 mph. The pilot applied forward control column to counter the pitch-up tendency, but there was no response. He then trimmed the nose forward, but the aircraft continued to pitch up until it stalled at about 50 feet above the water and the left wing dropped. The aircraft struck the water in the East Bay in a nose-down, 45° left bank attitude. On impact, the left wing and left float detached from the aircraft, and the aircraft came to rest on its left side. The crew was able to evacuate the passengers before the aircraft submerged, and local boaters assisted in the rescue. There were no serious injuries to the crew or passengers. The aircraft suffered substantial damage.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

The pilot was licenced in accordance with the *Canadian Aviation Regulations* (CARs) at the time of the occurrence. The pilot reported for duty at 0700 mountain daylight time<sup>1</sup> on the day of the occurrence, which was the first day of work for the pilot after a seven-day leave period. The pilot's flight duty times were within the prescribed limits. The pilot had three hours of sleep on the night preceding the occurrence. The accident flight occurred 12 hours after the pilot had reported for work.

Visual meteorological conditions existed at the time of the occurrence. A special weather observation recorded at the Yellowknife airport at 1919, approximately 10 minutes after the occurrence, was as follows: wind 310° True at 10 knots; visibility 15 statute miles (sm); showers in the vicinity of the airport; and few clouds at 4000 feet above ground level (agl), scattered clouds at 5000 feet agl, and scattered clouds at 6000 feet agl. There was no weather-recording equipment at the float base. The pilot estimated that the winds were 320° Magnetic<sup>2</sup> at 12 knots, gusting to 18 knots.

The occurrence aircraft was a de Havilland DHC-3T (Turbo) Otter, equipped with a Pratt and Whitney PT6-34A engine, serial number PCE-RB0058, and SI-3-8100 floats. It was certified to a maximum take-off weight of 9000 pounds under the Supplemental Type Certificate SA03-50.

The occurrence flight was preceded by a flight to Daring Lake that departed Yellowknife at 0826. While mooring at Daring Lake, the aircraft sustained damage to the left water rudder bracket. Upon returning to Yellowknife, it was determined that the rudder bracket would have to be repaired by removing the aircraft from the water and welding the bracket at Air Tindi's hangar at the Yellowknife airport.

To balance the aircraft on the float cart while pulling it out of the water, weight had to be added to the rear of the aircraft to prevent it and the cart from being too front-heavy. To accomplish this, 40 imperial gallons of fuel was added to the rear tank before the aircraft was towed from the water. The pilot and aircraft maintenance engineer also sat on the rear of the floats for added ballast.

The task of repairing the water rudder bracket was completed at about 1800, and the pilot took off to conduct a half-hour flight to burn off the fuel in the rear tank. However, before much fuel could be burned off, the aircraft returned to the Air Tindi float base, as the passengers for the 1800 flight were waiting at the dock.

Upon returning to the dock, the pilot began preparations for the impending flight. Aware of the tail-heavy configuration of the aircraft, the pilot requested that 20 to 30 imperial gallons of fuel be loaded into the forward fuel cell, in addition to the 50 imperial gallons already in the centre tank and the nearly 40 imperial gallons in the rear tank. While the pilot checked in with

---

<sup>1</sup> All times are mountain daylight time (Coordinated Universal Time minus six hours) unless otherwise noted.

<sup>2</sup> Variation at Yellowknife is 22° east.

dispatch, the ground crew finished loading the aircraft. An inexperienced dock hand, tasked with refuelling the forward fuel tank, added only 10 imperial gallons to the forward tank. The cargo was split into two components: 300 pounds secured in row five and the remaining 540 pounds in the aft cargo bay. Passengers were loaded in the front of the aircraft in the first four rows. The pilot was aware that insufficient fuel had been loaded onto the aircraft to counter the weight imbalance. However, as the passengers had already been loaded and the flight was one hour behind schedule, the pilot did not have further fuel added to the forward fuel tank. He was aware that the aircraft was likely aft of the centre of gravity (C of G) limit, but did not complete a C of G calculation.

Transport Canada has made provision for the use of standard weights for passengers where actual weights are not available.<sup>3</sup> This facilitates the calculation of total passenger weight without going through the time-consuming process of either querying passengers about their weight or actually weighing them.

Air Tindi used the standard passenger weights to calculate the total passenger weight. The published standard summer weight is 200 pounds for an adult male and 165 pounds for an adult female. The actual average weight for the male passengers was 230 pounds. The sole female passenger was 150 pounds. The actual total passenger weight was 1532 pounds as opposed to the 1365 pounds that was calculated using the standard passenger weight model. The aircraft's total take-off weight was 8873 pounds, which was below the 9000 pound maximum certified take-off weight.

The aircraft performance charts indicate a C of G aft limit of 148.3 inches at a weight of 8873 pounds. At the time of the occurrence, the aircraft's C of G was 158.8 inches aft of the datum. This was 10.5 inches aft of the C of G limit. The following is from the *Private Pilot Manual*:

With the C of G at or behind the centre 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 C of G makes it much easier to enter an accidental stall. ... Recovery may be impossible.<sup>4</sup>

The pilot and ground crew attendant escaped through the right cockpit door and assisted two passengers through this door. Water began to fill the cabin, rendering the cockpit door unsuitable for further evacuation. Two passengers escaped via the roof emergency exit. The pilot crossed over the fuselage, opened the right rear cargo doors, and assisted the remaining passengers from the aircraft. The ground crew attendant ensured that the assembled passengers remained together on the front of the right float of the aircraft. All crew and passengers were recovered by local boaters and returned to the Air Tindi dock.

---

<sup>3</sup> Transport Canada, *Aeronautical Information Manual*, TP 14371, RAC 3.5

<sup>4</sup> *Private Pilot Manual*, Englewood, CO. Jeppesen Sanderson, Inc., 1997, 8-45

Fatigue can have an insidious detrimental effect on human performance. The Transport Canada publication, *Crew Resource Management*, states the following: "Fatigue in aviation is recognized as a serious safety concern ... . Fatigued pilots are less vigilant, more willing to accept below-par performance and show signs of poor judgement."

## *Analysis*

The pilot did not complete a weight and balance report, which would have alerted him to the extreme aft location of the C of G. While the pilot was aware that the aircraft had an aft C of G, he did not fully appreciate the severity of how far aft the C of G was.

The accident occurred toward the end of a long duty day following a night where the pilot had only three hours of sleep. This, combined with the desire to satisfy customer needs on a flight that was one hour behind schedule, may have caused the pilot to rush the take-off preparations, thereby omitting the weight and balance calculation.

The success of the emergency egress of the crew and passengers can be attributed to the low-energy impact of the accident, and probably to the briefing given by the pilot. The aircraft remained in a more or less upright position and was not submerged during the evacuation. This allowed evacuees to easily orientate themselves toward the emergency exits. No one on board the aircraft sustained immobilizing injuries that would hinder escape. Additionally, the exits used during the evacuation were not jammed or blocked and were readily accessible. Finally, the pilot and assistant were able to retain command of the situation and effectively facilitate the evacuation of passengers.

## *Findings as to Causes and Contributing Factors*

1. The aircraft was loaded in such a manner that the C of G was beyond the rearward limit. This resulted in the aircraft's aerodynamic pitch control limitation being exceeded.
2. A weight and balance report was not completed by the pilot prior to departure and, as a consequence, he was unaware of the severity of the aft C of G position.

## *Finding as to Risk*

1. The weight of the passengers was underestimated due to the use of standard weights. This increased the potential of inadvertently loading the aircraft in excess of its maximum certified take-off weight.

## *Safety Action Taken*

Air Tindi adopted the following action items and policy changes to address the issues identified in the course of the investigation:

- It will no longer use fuel as ballast to adjust the weight and balance of an aircraft when towing.
- It increased operational oversight and conducted pilot briefings to ensure weight and balance calculations are completed prior to departure.
- It adopted and implemented a new procedure for weight and balance calculation.
- It elected to adjust the Transport Canada standard weights. The standard passenger weights will not be discounted for the lack of carry-on baggage. Adult male passengers will be assigned the standard weight of 200 pounds in the summer and 206 pounds in the winter. Adult female passengers will be assessed as 165 and 171 pounds, respectively, for summer and winter weights. The carry-on baggage that is not allowed within the passenger compartment will be weighed as part of the cargo and stowed in the cargo compartment.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 14 February 2006.*

*Visit the Transportation Safety Board's Web site ([www.tsb.gc.ca](http://www.tsb.gc.ca)) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.*