

AVIATION INVESTIGATION REPORT

A00C0059

LOSS OF CONTROL ON GO-AROUND

POINTS NORTH AIR SERVICES INC.

DOUGLAS AIRCRAFT COMPANY DC-3 C-FNTF

ENNADAI LAKE, NUNAVUT

17 MARCH 2000

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 Douglas DC-3 departed Points North Landing, Saskatchewan, about 1125 central standard time on a visual flight rules flight to Ennadai Lake, Nunavut, with two pilots and 6600 pounds of cargo on board. The flight was one of a series of flights to position building materials for the construction of a lodge. The pilots had completed a similar flight earlier in the day. The runway at Ennadai, oriented northeast/southwest, was an ice strip about 2700 feet long by 150 feet wide marked with small evergreens. The ice strip was constructed on the lake, and the approaches were flat, without obstacles. The snow was cleared so there were no snow ridges on the runway ends. The arrival at Ennadai Lake, toward the southwest, appeared to be similar to previous arrivals. The aircraft was observed to touch down nearly halfway along the ice strip, the tail of the aircraft remained in the air, and the aircraft took off almost immediately. The main landing gear was seen to retract. The aircraft reached the end of the runway then abruptly entered a steep, nose-up attitude, banked sharply to the left, turned left, and descended into the ice. The left wing made first contact with the ice. The aircraft rotated around the left wing and struck the ice in a steep, nose-down attitude about 400 feet from the end of the ice strip. There was no fire. The crew were killed instantly. Canadian Forces rescue specialists were air-dropped to the site on the day of the accident.

Ce rapport est également disponible en français.

Other Factual Information

The 36-year-old captain had approximately 8200 hours' flight time and held an airline transport pilot licence validated by an aviation medical certificate, endorsed on 26 May 1999. His Group 1 instrument rating was valid to November 2001. The captain had been employed by the company for about two and a half years. He had completed an initial pilot proficiency check as a DC-3 captain on 09 April 1999 and had about 840 hours on type.

The 53-year-old first officer had approximately 4300 hours' flight time and held a commercial pilot licence validated by an aviation medical certificate, endorsed on 12 November 1999. His Group 1 instrument rating was valid to November 2000. The first officer had been employed by the company as a seasonal pilot for several years and had been employed full time for the last year and a half. He had completed an initial pilot proficiency check as a DC-3 first officer on 04 November 1999 and had about 85 hours on type.

Points North Air Services Inc. operates in a sparsely settled area and provides service to fly-in communities. The DC-3 operation was initiated to provide large freight capacity to communities that are otherwise only accessible by barge or winter road for a few months of the year. Freight operations are carried out under visual flight rules to increase load capacity. The company was authorized to operate C-FNTF under Canadian Aviation Regulation (CAR) 705. Operation under CAR 705 requires flights to be conducted not less than 1000 feet above ground level (agl)¹ and with a flight visibility of not less than two miles. C-FNTF had been stripped to make the aircraft as light as possible, and the de-ice boots had been removed.

Weather obtained from the Ennadai Auto Station report for 1258 central standard time (CST)² was as follows: temperature minus 17 degrees Celsius, dewpoint minus 20 degrees Celsius, and wind 130 degrees true at eight knots. An estimate of the weather conditions, obtained from individuals who observed the landing of the occurrence aircraft, was as follows: ceiling from 1500 to 2000 feet agl and visibility from 1.5 to 2.0 statute miles in light snow.

On the day of the occurrence, the crew flew an early morning trip to Ennadai Lake and arrived back at Points North Landing at 1030. They then supervised the loading and the refuelling for the second trip, assisted by other Points North employees. The load consisted of two crates of construction materials, 26 sheets of plywood, a lift of 2x4 lumber 16 feet long, and a wrap of insulation bundles. The captain explained to the other employees that he wanted to obtain an aft centre of gravity (C of G) so that the aircraft would be less likely to nose-over if it ran through an uncleared area off the ice strip. To achieve the aft C of G, the captain chose to load the aircraft as shown in Appendix A. Information provided indicated that the employees assisting the crew suggested an alternate loading plan that positioned the 2x4s between the two crates. However, under the self-dispatch system used by the company, the aircraft captain is the authority for load positioning, and the captain's direction was followed. The section of the cabin used for the 2x4s did not have floor tie-downs, and the crew used wall attachment points to secure the load securing straps. The second flight departed within 55 minutes of arrival.

Examination of the ice strip revealed tire tracks that started about 300 feet short of the approach end of the ice

¹ Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.

² All times are CST (Coordinated Universal Time minus six hours).

strip through the snow. These tracks were made by the occurrence aircraft on the first trip to Ennadai Lake. Tire tracks were found on the ice strip terminating about the midpoint of the strip. Information indicated that these tracks were made during the overshoot on the accident flight.

Examination of the engines indicated that high power was being developed at impact. The left propeller was torn from the nose case of the engine, and all three propeller blades showed great bending. The left engine was torn from the engine mounts at the wing. The nose of the aircraft had been driven to the right and into the arc of the right propeller. The right propeller blade tips showed leading-edge damage and straight-line scratches consistent with the propeller coming into contact with debris or cutting through a section of the fuselage. Two of the three blades were bent, and the propeller was separated at the engine nose case.

Examination of the wreckage indicated that the aircraft was configured for a go-around. The right flap was at the quarter-flap extended position. The left flap's position could not be determined. Inspection of the main landing gear actuators indicated that both main wheels had been retracted. The aircraft flight controls were examined, and continuity was established throughout the elevator, rudder, and aileron controls. The elevator trim wheel and indicator were found jammed by impact forces. The way in which the jamming occurred indicated the trim had been set to at least 4 degrees nose-down before impact. The elevator trim has a range of 10 degrees nose-up to 10 degrees nose-down.

Wreckage examination confirmed the position of the loads in the aircraft and the method of tie-down as shown in Appendix A. The aircraft's nose and cockpit section were destroyed by impact forces. The fuselage failed in full-circumference just aft of the trailing edge of the wings. The two crates remained secured in this area. Several sheets of plywood also remained in place in front of the fuselage failure. The fuselage, aft of the wings, and the tail were twisted to the left and downwards. The remainder of the plywood sheets had dropped into the space in the fuselage opening aft of the wings. A second, almost full-circumference failure of the fuselage occurred in the vicinity of the forward portion of the vertical fin and ahead of both horizontal stabilizer attachments. All of the 2x4s were found in the rearmost section of the fuselage, with a large number found aft of the rear bulkhead.

Aircraft documentation indicated that the forward and aft limits of the C of G were 239.6 inches and 263.1 inches, respectively, and that the maximum take-off weight was 26 900 pounds. The aircraft weight and balance report dated 18 December 1995 showed the basic operating weight as 18 406 pounds and the C of G as 238.2 inches. The basic operating weight and C of G were used to calculate an aircraft empty operational index number. The crew used the index number in a graph on the aircraft load sheet to compute the C of G with the aircraft loaded.

It was learned that the crew did not recalculate the weight and balance for the second flight. Instead, they used the completed load sheet from the first flight since the total load was of about the same weight. The crew used an operational index number of 13 in this calculation, based on the weight and balance report of 18 December 1995. The weight and balance report was submitted to Transport Canada and placed on the aircraft file. The report was not reviewed for accuracy, nor was Transport Canada required to do so.

Following the occurrence, the basic operating weight and C of G provided in the weight and balance report were found to be incorrect. The correct basic operating weight and C of G were determined to be 18 502 pounds and 254.9 inches, and the corrected index number was 44.8. The corrected C of G was 16.7 inches aft of that provided in the weight and balance report. The C of G and take-off weight of the aircraft on the accident flight were recalculated from the available information and the corrected basic operating weight and C of G. The recalculated C of G was found to be 295.4 inches—32.3 inches aft of the aft limit. The take-off weight was

26 723 pounds.

The company's DC-3 operations are controlled by published standard operating procedures (SOPs). Section 2.4 of the company SOPs specifies that the first officer shall complete all required weight and balance documents before each flight. The captain shall review the documents and ensure that the required information is properly completed.

Toxicological tests did not reveal the presence of alcohol or any other intoxicating drugs in the blood of the captain or the first officer. However, the levels of carbon monoxide in the blood of both crew members were elevated. The captain's carboxyhaemoglobin level was 17.9 per cent, and the first officer's level was 8.7 per cent. It was learned that the captain smoked more than one package of cigarettes per day and that the first officer was a non-smoker. Cigarette smokers may routinely have saturation levels of 6 to 8 per cent, and the effects of carbon monoxide are cumulative. Tolerance to carbon monoxide is not increased by smoking.

Many different classifications of severity of carbon monoxide poisoning are documented, indicating that the severity of symptoms does not correlate well with carboxyhaemoglobin levels. Generally, saturation levels of less than 5 per cent are not considered to cause any obvious symptoms. At saturation levels less than 25 per cent, physiological functions and the performance of skilled physical tasks are rarely affected. However, complex psychological functions involving judgement, situational decisions, and responses would be affected by levels between 5 and 20 per cent.³ Some classifications indicate decreased visual acuity at saturation levels of 10 to 20 per cent.⁴ Once the victim of carbon monoxide poisoning is removed from the carbon monoxide source, the levels decline. Information indicates that the half-life of carboxyhaemoglobin is about five hours. Altitude affects the saturation level because the partial pressure of oxygen decreases with altitude. Information concerning the altitude of the flights was not available.

Apparently, a carbon monoxide detector had been mounted in the cockpit of C-FNTF and was to be replaced when its condition required. The detector was not included in the aircraft equipment list. The carbon monoxide detector was a small, plastic square with a brownish circle around a brown detection spot. The detection spot turns a darker colour than the circle in the presence of carbon monoxide. Detectors of this type are commonly used in light aircraft and are usually attached to the instrument panel. When mounted, the user directions that are printed on the back of the detector are no longer visible. These directions indicate that the detection spot will turn dark brown to grey/black when exposed to carbon monoxide and that even a slight darkening may indicate a dangerous level of carbon monoxide. The directions also state that when the air freshens, the spot will return to its original colour and match the brown circle. The detector can be rendered unserviceable by exposure to various common chemical vapours and should be replaced every 30 to 60 days, since the detection spot gradually turns darker or bleaches out over time. The detector has no warning system to alert the crew to its condition. It could not be determined whether either crew member understood the directions or checked the indicator before or during the flight. The detector was not found during the examination of the wreckage.

The left and right engine exhaust cabin heat exchangers were examined at the regional wreckage examination facility. The right heat exchanger was pressure decay tested and found to have no leaks. The left heat exchanger was damaged to such an extent that a pressure decay test could not be performed. The heat exchanger was cut open, and a visual examination found no pre-impact failures.

³ Peter J. Stevens, *Fatal Civil Aircraft Accidents, Their Medical and Pathological Investigation*, John Wright & Sons Ltd., 1970.

⁴ <http://www.phymac.med.wayne.edu/FacultyProfile/penney/COHQ/co1.htm>

The Janitrol heater, model number S200, part number 27C56, was removed from the wreckage, and a pressure decay test was performed at the regional wreckage examination facility. A leak was found and was determined to have existed before impact. The leak would have allowed exhaust gas to enter the cockpit environment through the heater outlets. The heater can was forwarded to the TSB Engineering Laboratory. Further examination found two additional cracks, which would have allowed exhaust gas to enter the cockpit environment. Perforation of the inner burner can result from localized high-temperature oxidation and erosion of the Inconel alloy steel metal.

The company's maintenance facility had maintained the heater in accordance with the inspection program listed in their approved maintenance control manual. The inspection program required the heater to be overhauled every five years or 2500 hours, whichever came first. The manufacturer's maintenance instruction manual for the S200 heater, part number 27C56, lists inspection and overhaul procedures but does not specify their recommended intervals. The maintenance instruction manual for similar heaters requires the heater to be inspected at 100-hour intervals and overhauled at 500-hour intervals. Correspondence with the heater manufacturer indicates that heaters with this part number are no longer in production.

Analysis

The analysis will discuss the loss of control during the go-around, pilot decision-making under the influence of carbon monoxide, and carbon monoxide warning.

Wreckage examination did not uncover any control system or engine problem that would have led to a loss of control during the go-around. Two scenarios leading to loss of control were considered. First, the C of G, at about 32.3 inches aft of the aft limit, could have resulted in a loss of control. While the crew had been able to control the aircraft throughout the flight, the amount of elevator control remaining would have been marginal and may have been insufficient during the configuration changes and acceleration of the go-around. The nose-down trim position is probably an indication that the aircraft's C of G was aft of normal. Second, a large number of the 2x4s were found aft of their original position, whereas the impact forces were predominantly forward. The securing of the 2x4s, as shown in Appendix A, would not have prevented their movement, and the stack of 2x4s may have shifted rearward during the acceleration and raising of the nose for the go-around. This would have moved the C of G further aft, causing the loss of control. However, the movement of the 2x4s could also have happened after the loss of control occurred and the aircraft entered the abrupt manoeuvre.

As detected by toxicological tests, the carbon monoxide saturation levels found in the captain likely did not affect his ability to fly and control the aircraft. However, the levels were in a range in which judgement, decision making, and visual acuity may have been adversely affected. On the first flight, the aircraft landed short of the ice strip; on the second, the aircraft landed near the halfway point of the strip. Both of these landings may have resulted from degraded judgement or degraded visual acuity in a demanding landing environment with minimal visual cues.

The landing short on the first flight and the run through the snow short of the runway likely convinced the pilot that an aft C of G was preferable to prevent a nose-over if a similar situation occurred. The subsequent decisions about the positioning and securing of the 2x4s and the use of the previous weight and balance calculation resulted in a dangerous situation. The crew overlooked a major change in the weight and balance of the aircraft and an inadequate securing method, possibly indicating that the decision-making ability of the crew members was diminished by the level of carbon monoxide poisoning. Since the half-life of carboxyhaemoglobin is about five hours, the brief stopover between flights would not have significantly

reduced the level of carbon monoxide saturation.

Because of the self-dispatch system, there was no back-up system to check loading decisions made by the crew. The crew's decision making would have also been affected by the incorrect index number. Over time, the use of a too low index number would give the impression that greater weights could be placed in the aft sections of the cabin than would otherwise be allowable.

The carbon monoxide detector was not found. However, had it been serviceable, the spot would have changed colour. If the detector was time expired, the spot would have also been a different colour than the surrounding circle. The crew did not have the device changed or take any action to prevent carbon monoxide poisoning. It is therefore possible that they did not include the detector in their cockpit scan and, thus, did not observe any change in the colour of the detection spot. Activation or unavailability of the detector could go unnoticed since the device is passive and has no warning system to attract the attention of the crew. Further, it is unlikely that the crew understood the limitations of the detector since the instructions are hidden once the device is mounted in the cockpit.

The following TSB Engineering Laboratory Report was completed:

LP 68/00—Janitrol Heater.

Findings as to Causes and Contributing Factors

1. The pilot lost control of the aircraft while conducting a go-around from a balked landing on an ice strip.
2. The aircraft's centre of gravity (C of G) on the accident flight was beyond the aft C of G limit.
3. The actual C of G of the aircraft at basic operating weight was 16.7 inches aft of the C of G provided in the weight and balance report.
4. The load sheet index number used by the crew was inaccurate.

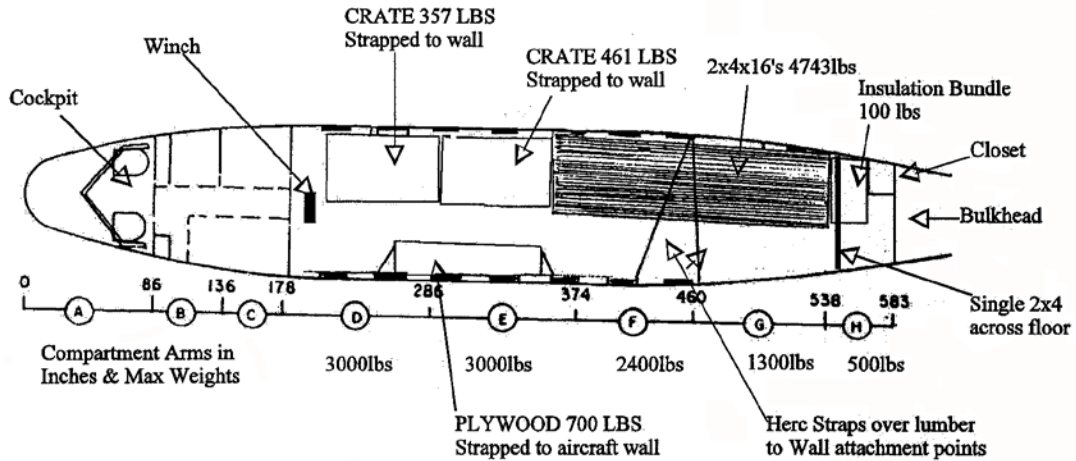
5. The stack of 2x4 lumber was inadequately secured and may have shifted rearward during the go-around.
6. The crew did not recalculate the aircraft's weight and balance for the second flight.
7. Leaks in the heater shroud allowed carbon monoxide gas to contaminate cockpit and cabin air.
8. The captain's carboxyhaemoglobin level was 17.9 per cent, which may have adversely affected his performance, especially his decision making and his visual acuity.

Other Findings

1. The carbon monoxide detector had no active warning system. The user directions for the detector, which are printed on the back of the detector, are obscured when the detector is installed.
2. The company maintenance facility overhauled the heater as required by the Transport Canada-approved inspection program.
3. Although the manufacturer's maintenance instruction manual for the S200 heater, part number 27C56, lists inspection and overhaul procedures, it does not specify their intervals.
4. No maintenance instructions are available for the heater, part number 27C56. The company maintenance facility did not conduct inspections, overhauls, or pressure decay tests as specified for later manufactured heaters.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 29 March 2001.

Appendix A—Load Distribution



C-FNTF LOAD DISTRIBUTION

Notes

1. First 2-3 rows of 2x4's extend beyond edge of rear crates.
2. Herc straps over lumber are attached to aircraft wall not floor points.
3. Insulation bundle extends beyond closet.
4. Weight of 2x4's exceeds combined weights of Compartments F & G