AVIATION OCCURRENCE REPORT

POWER LOSS/COLLISION WITH TERRAIN

BEAVER AIR SERVICES LTD.
PIPER PA31-310 NAVAJO C-GERV
PUKATAWAGAN, MANITOBA
19 DECEMBER 1996

REPORT NUMBER A96C0267

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Summary

The Beaver Air Services Ltd. Piper Navajo PA31-310, serial No. 31-7612107, was departing Pukatawagan at night, on a visual flight rules (VFR) company flight notification to The Pas, Manitoba. The pilot boarded the six passengers and a small amount of hand luggage. Shortly after engine start, the pilot configured the aircraft with 15 degrees of flap, which is normally used for a short field take-off, and backtracked to the threshold of runway 15. The aircraft accelerated normally and the pilot rotated at 85 mph. Immediately after the aircraft became airborne, the left wing dropped sharply. The pilot levelled the wings; however, the aircraft was now off to the side of the runway, and the pilot lost sight of the runway lights. He noticed the left engine surging and decided to carry out an engine failure procedure. He moved the landing gear lever to the UP position and, concerned about rising terrain to the left of the runway, pulled back on the control column while maintaining a wings-level attitude. The aircraft descended rapidly into the terrain to the left of the runway, struck the ground in a nose-high attitude, and slid about 150 metres through deep snow. The aircraft came to rest about 100 metres to the left of the departure end of the runway. One passenger sustained a back injury.

Ce rapport est également disponible en français.

Other Factual Information

The runway at Pukatawagan is 2,850 feet long. There is a downslope towards the departure end of runway 15. At the departure end of runway 15 there is a deep gully, after which the terrain immediately rises about 100-125 feet. This rise in elevation occurs directly in line with the runway, about 600 feet past the end of it. To the left of the runway, across the gully, the terrain also rises quickly about 100 feet. The terrain causes turbulence off the end of runway 15, particularly in the warmer months or when there is strong wind. Because of the rising terrain off the end of runway 15, the accepted practice for company pilots was to use a short field take-off procedure for the Navajo on this runway. The short field take-off procedure is authorized in the PA31-310 Approved Flight Manual (AFM).

The pilot reported that there was a high overcast ceiling with about six miles visibility in light snow at Pukatawagan. The wind was about five knots from the south, and favoured take-off on runway 15. These conditions were consistent with reports from other aerodromes in the area and from another company pilot awaiting take-off on the taxiway about halfway along the runway. The take-off was conducted in darkness, and there were no lights on the ground beyond the end of the runway. The company pilot waiting on the taxiway observed that the occurrence aircraft crossed the mid-point of the runway at a higher-than-normal altitude. After the aircraft passed his position, he observed it to descend rapidly and crash. Several occupants on the occurrence aircraft reported hearing a warning horn after take-off.

The pilot completed his initial flight training in 1992 and subsequently gained experience with several small aviation companies. He obtained a commercial pilot licence with a multi-engine land and sea aeroplane endorsement, and an instrument rating in 1994. Prior to joining Beaver Air Services, the pilot had accumulated approximately 1,400 hours total flight time, with approximately 900 hours on multi-engine aircraft, primarily the Britten Norman Islander. The pilot completed his Navajo training with Beaver Air Services and flew a successful pilot proficiency check (PPC) with a Transport Canada inspector on 21 November 1996. The training and the PPC were completed in a Piper PA31-350, Chieftain. For the purposes of pilot proficiency, the PA31-310 and PA31-350 are grouped together and the PPC is valid in either model. At the time of the occurrence, the pilot's experience on the PA31, both the 310 and 350 combined, was about 70 hours and he was qualified to fly the aircraft single-pilot IFR. He had completed his aviation medical in July 1996.

The pilot indicated that his decision to continue with the take-off, following his detection of an engine anomaly, was primarily based on the inadequate runway length on which to land and the rugged terrain under the flight path. The pilot indicated that he did not have to use a significant amount of rudder to stop the aircraft from yawing. He reacted to the engine emergency immediately by cycling the landing gear up to reduce drag. The pilot was concerned about the aircraft's proximity to rising terrain and pulled back on the control yoke. He did not try to establish an airspeed or aircraft attitude and had no recollection of aircraft attitude or airspeeds during the emergency other than the rotation speed of 85 mph. He maintained full back pressure on the yoke until he heard the stall warning horn. He relaxed some back pressure, but the aircraft struck the ground before he could take any other action.

The aircraft was examined after the occurrence, and no faults with the airframe or fuel delivery system could be found. The fuel was clean, bright, and free from contamination or suspended ice particles. The left engine was removed and examined in the TSB regional facility. The examination revealed no discrepancies except

for two loose clamps on the turbocharger compressor discharge housing duct. Technical records indicated that the exhaust transition assembly on both engines had been replaced about three weeks prior to the accident, necessitating the loosening of the two clamps.

The left engine was mounted in a test cell and fitted with a fixed pitch test club propeller. The engine turbocharger and fuel systems were left intact and run "as is." The clamps on the turbocharger compressor discharge housing duct were left loose. The engine was primed and started on the second attempt. The engine was run at a low power setting and was brought up to normal operating temperatures. A magneto check was done and normal rpm drops were experienced. The engine was then run to 2,000 rpm and a fuel flow check confirmed normal pressure and flow. The engine was brought up to 2,575 rpm to simulate take-off power. As the engine reached 2,575 rpm, there was a sudden drop of 500 rpm in engine speed and a drop of five inches of manifold pressure. The engine surged momentarily and then regained rpm. Several further attempts were made to reproduce the sudden engine surge; however, none were successful. Subsequently, the engine ran normally at 2,575 rpm with a normal turbocharger boost pressure of 39 inches manifold pressure with the turbocharger compressor discharge housing duct clamps left loose. Because of safety requirements, it was not feasible to simulate an instantaneous air leakage at the duct clamps during the test run.

The aircraft engines are equipped with compressor bypass doors on the induction housings. The AFM indicates that in the event of a turbocharger compressor failure, the engine will automatically revert to normally aspirated operation, or approximately 75% of normal rated power.

Analysis

The analysis will concentrate on the issue of the surging left engine, and the procedure followed by the pilot in reaction to the engine problem.

The magnitude of the engine surge that was observed during the initial engine run in the test cell likely duplicated the reported engine surge experienced during the occurrence. Consequently, it is likely that the engine was producing partial power during the take-off. It should be noted that the drop of 500 rpm experienced during the initial engine test run would not likely occur when the engine and its governing propeller system are mounted in the aircraft; however, a similar drop in manifold pressure and engine power would be expected. A scenario of partial power is consistent with the pilot's observation of not having to use a significant amount of rudder to counteract yaw. Because no other fault could be found in the engine to explain the surge, it is possible that the loose clamps allowed an unsealing of the duct, thereby producing an instantaneous change in the turbocharger discharge pressure which then resulted in the engine surge. Because it was not feasible during the test cell run to reproduce an instantaneous change in the turbocharger discharge pressure, it was not possible to directly link the loose ducting to the engine surge. However, if such a leak had occurred, the engine could have momentarily reverted to the normally aspirated mode, and the engine power would have been reduced by as much as 25%, producing a surge in the engine. It is likely that the loss of thrust when the engine surged caused the left wing to drop.

Under the circumstances, with the aircraft's left engine likely producing partial power, the right engine producing full power, and a deep gully lying along the flight path, the pilot's decision to continue with the take-off was likely the best decision. However, the pilot's unawareness of his actual airspeed and aircraft

attitude during the event and his maintenance of full aft pressure on the control yoke probably placed the aircraft in an abnormally high pitch attitude. The higher-than-normal pitch attitude, coupled with the available engine power, likely caused the higher-than-normal departure path of the aircraft as observed by the company pilot waiting on the taxiway. Although the engines were likely producing sufficient power to continue the take-off, the higher-than-normal pitch attitude, the slow speed regime, and the high drag configuration of the aircraft probably combined to further reduce the airspeed of the aircraft until it approached the aerodynamic stall speed. The stall warning horn heard by the pilot and by several passengers also corroborates the scenario that the aircraft was approaching an aerodynamic stall. As the aircraft approached the stall, it descended rapidly into the terrain.

Findings

1. The pilot was certified and qualified for the flight in accordance with existing regulations.

2. The left engine surged immediately after the aircraft became airborne.

3. During a test cell run, the engine surged momentarily; however, the surge could not be subsequently reproduced or isolated.

4. The two clamps securing the duct between the compressor discharge housing and the engine fuel controller inlet housing were loose. A sudden leak at this location could cause the engine to surge.

5. The clamps may not have been adequately tightened during maintenance conducted three weeks prior to the occurrence.

6. After the engine surge, the pilot pulled back fully on the control column in an attempt to clear rising terrain.

7. The aircraft was likely approaching an aerodynamic stall prior to ground impact.

Causes and Contributing Factors

The left engine surged immediately after take-off for reasons which could not be determined. While attempting to continue the take-off, the pilot allowed the airspeed to decrease close to the aerodynamic stall speed. A high rate of descent developed, and the aircraft descended into the terrain on the airfield.

Safety Action Taken

Following the occurrence, all of the company's Navajo pilots flew a review program simulating single engine procedures.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the

Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 17 September 1997.