Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A06C0181

DEPARTURE FROM RUNWAY SURFACE

PERIMETER AVIATION LTD.
SWEARINGEN AIRCRAFT CORPORATION
SA226-TC C-FTNV
NORWAY HOUSE, MANITOBA
08 NOVEMBER 2006

Canada

Aviation Investigation Report

Departure from Runway Surface

Perimeter Aviation Ltd.
Swearingen Aircraft Corporation
SA226-TC C-FTNV
Norway House, Manitoba
08 November 2006

Report Number A06C0181

Summary

The Perimeter Aviation Ltd. Swearingen Aircraft Corporation SA226-TC (registration C-FTNV, serial number TC-239E) was on a flight from Winnipeg, Manitoba, to Norway House, Manitoba, with two crew members and seven passengers on board. After touchdown on Runway 05, when propeller reverse was selected, the aircraft veered to the left. The crew attempted to regain directional control; however, the aircraft departed the left side of the runway surface, entered an area of loose snow, traversed a shallow ditch, climbed a rocky embankment, and came to rest on its belly with all three landing gears collapsed. The crew and passengers exited the aircraft through the main door stairway and the over-wing exits. There were no reported injuries. The accident occurred during daylight hours at 0834 central standard time.

Ce rapport est également disponible en français.

Other Factual Information

Crew

The captain held a valid airline transport pilot licence, endorsed for the SA226-TC, with over 6000 hours of total time and approximately 4500 hours on type. He had flown 45 hours in the last 30 days. In the 24-hour period before the accident, the captain had flown a series of flights in the accident aircraft. The captain was off duty at 1800, reported for duty at 0600 on the morning of the accident flight, and was well rested. The first officer also held a valid airline transport pilot licence for aeroplanes, endorsed for the SA226-TC. He had over 4000 hours of total time and approximately 15 hours on type, flown in the last 30 days. In the 24-hour period before the accident, the first officer was off duty. He reported for duty at 0545 on the morning of the accident flight and was well rested.

Aircraft

Maintenance records indicate that the aircraft was maintained and certified in accordance with accepted standards. The aircraft was being operated within approved gross-weight and centre-of-gravity limits.

Weather

The weather at the time of the accident was reported by the Norway House automated weather observation station (AWOS) at 0800 central standard time[1] as follows: visibility nine statute miles; ceiling 600 feet overcast, 1200 overcast, 4700 overcast; temperature -7°C; and wind 010° true (T) at six knots. The AWOS ceiling was transmitted to the crew approximately 11 minutes before the accident. For the landing on Runway 05, the wind was a 45° crosswind from the left at six knots.

Airport

The elevation of the Norway House Airport (CYNE) is 734 feet above sea level. The surface of Runway 05/23 is crushed rock, and the runway is 3922 feet long and 100 feet wide. At the time of the occurrence, the runway was 10 per cent bare and dry and 90 per cent compact snow. The runway edge lights are located 10 feet outside the edge of the runway and snow had been cleared to within 3 feet inside of the edge lights. The cleared snow had been thrown past the runway edge lights, at a depth of snow progressively increasing from 0 to approximately 3 inches as the snow reached the edge of the extended surface beyond the runway edge lighting.

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1 All times are central standard time (Coordinated Universal Time minus six hours).

Occurrence Flight

On start-up for the occurrence flight, both propellers came off the start locks normally. When taxiing from the departure terminal to the runway at Winnipeg, the crew did not use thrust reverse, nor was it an operational requirement to do so. During taxi and take-off, the nosewheel steering, the brakes, and the flaps functioned normally. The take-off and climb-out were uneventful. While en route, the propeller synchronization system did not automatically maintain synchronized propeller speeds, and the crew manually controlled propeller synchronization. Normal engine operating temperatures and pressures were noted. There were no cautions or warnings displayed before or during the landing at Norway House.

On landing, the aircraft touched down near the centre of the runway, approximately 300 feet beyond the threshold. Both sets of main wheels straddled the approximate centreline of the runway then tracked in a continuous straight line for 270 feet. The nosewheels touched down and all three landing gears tracked in a straight line for an additional 250 feet. The tracks then arced left to approximately 35° left of the runway heading, straightened for a short distance, then commenced a gradual arcing turn to the right. That turn continued as the aircraft proceeded through the row of the runway edge lights and off the left side of the runway, approximately 1000 feet from the point of touchdown. The arcing right turn continued as the aircraft descended into a snow-filled ditch adjacent to the runway. From the initial touchdown to the point where the aircraft departed the runway, all tire marks were continuous and uniform in nature.

The three landing gear assemblies failed rearwards as the aircraft encountered a snow-covered rocky embankment. The aircraft came to rest in an upright attitude, with the tail of the aircraft approximately 40 feet off the left side of the runway, 1800 feet from the runway threshold.

Aircraft Systems

The nosewheel steering was not being used by the crew when the aircraft turned to the left and away from the runway heading. Tracks on the runway indicated that the nosewheels were castering normally with no evidence of skidding or wide-tracking to indicate that steering inputs had been applied. Impact damage to the nosewheel actuator and nosewheel steering position sensors precluded functional testing.

The aircraft brakes were not being applied at the time that the aircraft turned away from runway heading. Tracks on the runway were continuous and uniform in nature with no indication of skidding or dragging. After the occurrence, the main wheels were free-turning and there was no indication of overheating of the brake components. The aircraft wing flaps were retracting when the aircraft turned to the left, and both flaps were at the same relative position. The engines, propellers, brakes, and flap components were damaged and could not be functionally tested.

Cockpit Voice Recorder

The aircraft was equipped with a functioning cockpit voice recorder, which was analyzed at the TSB Engineering Laboratory. Spectral analysis of the propeller and engine sounds indicated that both engines were running and the propellers were producing sounds consistent with an estimated 1935 rpm; however, the resolution of the sonogram program used during analysis was not sufficient to ensure precise rpm measurement.

Beta System Indication

The engine and propeller controls incorporate a Beta system for each engine. After landing, when the power levers have been selected to ground idle, Beta pressure builds to a prescribed value to activate Beta lights for each engine. The Beta lights may come on separately; however, when Beta system pressure is achieved for both engines, thrust reverse should function in a relatively uniform manner.

Aircraft Damage

The aircraft incurred substantial damage:

- the three landing gear assemblies failed;
- both propellers and engines were damaged as a result of propeller ground strike;
- both engine mounts suffered bending deformation; and
- due to the extent of damage incurred on contact with the rocky embankment, the aircraft was assessed as non-repairable.

Propellers

The left propeller drive decoupled from the engine within the gearbox assembly. The right propeller drive remained coupled to the engine despite extensive propeller blade damage. Both propellers were being driven by the engines when the propeller blades struck the ground. Ground contact and subsequent blade bending turned the blades beyond normal reverse travel limits. Teardown and assessment of both propellers indicated that there were no internal pre-impact failures. Light marks were noted at the same relative position on the Beta tubes for both propellers. Based on these marks, the propeller blades were calculated to have been at approximately 10° when the marks were made.

Power Controls

The power lever and speed lever cables from the cockpit to each engine maintained their attachment and integrity. The engine mounts were distorted, and the engine nacelles were displaced during the accident. Post-accident examination indicated that, when the power levers were selected to the flight idle position in the cockpit, both propeller pitch controls indicated a 42° position on the propeller pitch index and full travel was achieved when the controls were moved to full reverse. The left power lever movement achieved full range of travel at the engine. The displacement of the right engine was much more pronounced than that of the left engine, and as a result, the right power control only attained 95 per cent of full travel in the high power range. When the power lever cables were disconnected, full travel was available for propeller pitch and fuel controls. All control rods and linkages on both engines were correctly attached and maintained their integrity after the occurrence.

Fuel Control Mounting and Support

The fuel control assembly is made up of a fuel pump, a fuel control unit, a flow regulator, and a concentric control input shaft. The mounting pad for the fuel pump, at the rear face of the engine accessory drive case, is designed as the primary attachment and support for the fuel control assembly. The fuel control assembly weighs approximately 25 pounds and extends more than 12 inches rearwards and below the engine accessory case. Eleven inches aft of the fuel pump mount, a two-piece triangular support assembly is attached to a split line on the engine case and, below that, to the fuel control assembly. Three bolts on the accessory case attach the upper support assembly (part number 868767-1) to the engine case (see Photo 1). Two bolts fasten the lower support (part number 867915-1) to the upper support completing the triangular shape and providing a bolt hole at the lower point of the triangle to attach the lower plate to the fuel control assembly. Spacers are brazed onto the three upper bolt holes to accommodate alignment of the lower support at the fuel control attachment.

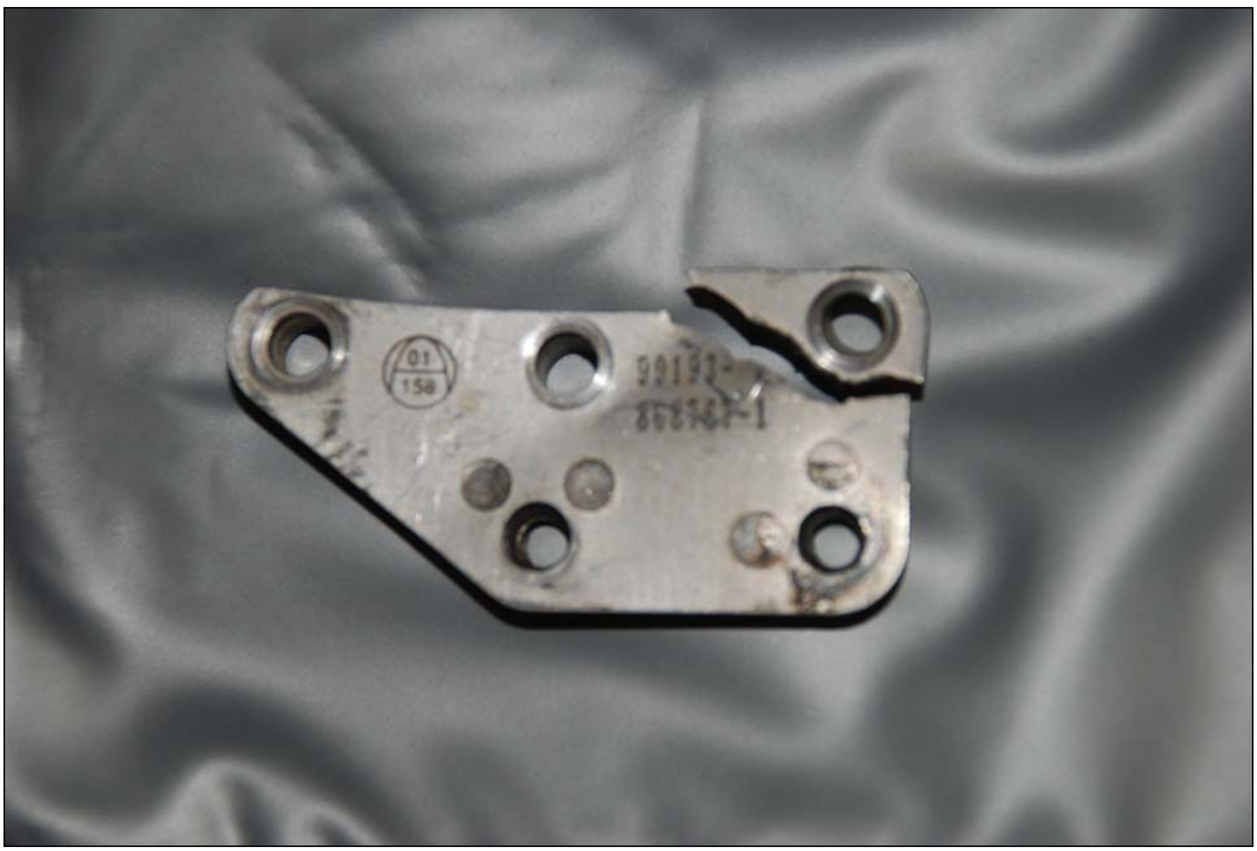

Photo 1. Left engine fuel control upper support assembly

When the left fuel control assembly was removed, the inboard corner and the corresponding attachment bolt of the part number 868767-1 support assembly were attached to the engine case, but separate from the remainder of the assembly. The centre bolt and the outboard bolt were in place on the remainder of the support assembly. A space was evident between the two separated pieces indicating that the outboard portion of the support had rotated slightly and moved downwards. Engineering examination confirmed that the support assembly failed as a result of progressive fatigue cracking that had initiated in the vicinity of a spacer braze and progressed in two directions to both ends of the fracture face. Additionally, the braze material at the centre bolt spacer showed that similar cracking was commencing at several locations adjacent to that fastener.

After the support assembly failed, any loads applied to the fuel control were transferred to the remaining two bolts. The change in support resulted in a shifting of the support assembly and a subsequent change in the position of the fuel control. With the fuel control removed, the failed support components remained separated by 0.125 inches. It is suspected that, under the effects of loading, that separation could have been as much as 0.25 inches. A change in the position of the fuel control would result in a repositioning of the concentric control shaft and a corresponding change in dimensions at the propeller controls. The corresponding support bracket for the right engine remained intact.

Fuel Control and Propeller Governor Examination

The stacked fuel control assemblies, along with their inlet temperature and pressure sensors, were removed as complete units from each engine. These assemblies and the propeller governors were forwarded to the TSB Engineering Laboratory for functional testing. The components were subsequently taken to the manufacturer where the testing was accomplished. The left fuel control assembly and both propeller governors tested within normal limits. The right fuel control assembly and the inlet temperature and pressure sensor showed indications of higher-than-normal flows. Assessment of the fuel control indicated that the unusual flows resulted from repositioning of internal splines, likely as a result of impact. The inlet temperature and pressure sensor was found to have been stretched, a condition that was also considered to be impact-related. A higher flow rate for these components would have resulted in more power on the right engine. If the condition had existed at the time of the landing, the reverse thrust would have been greater for the right propeller and the aircraft would have turned to the right instead of to the left. It was concluded that both fuel controls were functioning normally at the time of the occurrence.

SA226 Normal Operating Procedures

The Swearingen Metro SA226-TC normal operating procedures checklist for landing contains a note indicating that, after the power levers are moved to ground idle, the pilot is required to check that both Beta lights are on before moving the levers to reverse. The checklist item following that note indicates that the power levers can then be moved to reverse as required.

Company Standard Operating Procedures

At touchdown, the pilot flying (PF) will call for FLAPS UP and the pilot not flying (PNF) will select the flaps up. There is a note indicating that flap retraction shall only be conducted on gravel strips and only with extreme caution once the main gear is on the ground. The procedure continues: Once the Beta lights illuminate, the PNF will call Beta lights “On” and as the aircraft decelerates through 70 knots, the PNF will call “70 knots.” At this time, the PF will have to make a decision. Normally, the PF will call for “Speed Levers Low”; however, this will not be done automatically, such as in the case of reverse pitch or high exhaust gas temperature (EGT) situations. The PF will only call for speed levers low if the power levers are at or forward of ground idle.

The Beta light call was not requested when the crew briefed during the pre-landing briefing nor is it required by the standard or normal operating procedures. After touchdown, thrust reverse was applied without a Beta light call.

The use of propeller reverse is at the discretion of the pilot. The captain who flew the last flights with the aircraft on the day before the occurrence flight did not use propeller reverse on landing. The aircraft was reported to have operated normally in all respects on those flights.

Analysis

Weather and Runway

Weather and runway conditions were appropriate for the landing and are not considered to have contributed to the deviation of the aircraft from runway heading. The tire marks on the runway indicated that the nosewheel steering and aircraft brakes were not applied. As the aircraft turned to the left of runway heading, the marks were consistent with the effects of an asymmetric thrust condition with more reverse thrust produced by the left propeller than the right. The tracks straightened for a short distance, suggesting that both propellers were providing a balanced reverse thrust, and then turned to the right in response to the control input applied by the crew.

Engines and Propellers

The calculated propeller rpm of 1935 was lower than normal, but the difference may be the result of the limitations of the sonogram program. The damage to both propeller blades was consistent with ground strikes under power. However, the degree of bending may have been lessened due to the effects of the propellers contacting loose snow before gear collapse.

The integrity and attachment of all controls were confirmed after the occurrence. The engine controls functioned normally, considering the deformation of the engine mounts and nacelles. After the speed and power lever cables were disconnected, all engine controls and component control rods functioned normally. The controls are installed and adjusted to provide simultaneous operation of both engines and propellers when their respective power levers and speed levers are set to matching positions. Because the propeller pitch control and the propeller governor are mounted independent to the fuel control, any change in fuel control position would alter the control inputs between these units and the fuel control. Because the left engine fuel control support assembly failed, the sequencing of the Beta pressure and Beta light activation would change for that engine only. The Beta system pressure increase and the subsequent activation of the Beta lights would occur for both engines, but they would not activate at the same time.

The propeller synchronization and all other engine and propeller functions were normal on flights accomplished the day before the occurrence. The propeller synchronization problem noted on the occurrence flight may have been the first indication of the effects of the failed support assembly. Therefore, the failure of the left fuel control support likely occurred on the last landing of the previous day or during the occurrence flight.

Procedures

The PF is directed in the SA226 normal operating procedures to check that both Beta lights are on before moving the power levers to reverse. The Perimeter Aviation Ltd. standard operating procedures direct the PNF to call Beta lights ON when the Beta lights illuminate after landing. However, there is no requirement to include the Beta light call as part of the pre-landing briefing. Briefing this item would reinforce the requirement to select reverse only after both Beta systems activate and provide a timely indication that the system is ready to produce reverse thrust for both engines.

It was determined that the aircraft deviated from runway heading when the propellers were selected to reverse after touchdown; propeller reverse was selected before a Beta light call was made. A fuel control support assembly failure on the left engine likely resulted in a dissimilar activation of Beta pressure between the engines. Because the aircraft veered off the runway shortly after the application of thrust reverse, it is most likely that thrust reverse was applied before both Beta lights were on, which resulted in a momentary asymmetric thrust condition.

The normal operating procedures require confirmation of both Beta lights before application of thrust reverse. This procedure should preclude development of an asymmetric thrust condition in the event of a propeller system failure. Although the Beta lights may come on separately, when both Beta lights are on, Beta system pressure is available and the onset of thrust reverse should be relatively symmetrical.

The following TSB Engineering Laboratory reports were completed:

LP 050/2007 – Fuel Control Bracket Examination
LP 030/2007 – Component Testing

These reports are available from the Transportation Safety Board of Canada upon request.

Findings as to Causes and Contributing Factors

1. The left engine fuel control support assembly failed in fatigue and released one of three attachment bolts, which resulted in a slight displacement of the fuel control and changed the propeller control dimension. As a result, Beta pressure was achieved and propeller reverse was available for the left engine before it was available for the right engine.

2. The pilot selected thrust reverse without confirmation that the Beta lights were on for both engines, and the aircraft veered from the runway, most likely as a result of temporary asymmetric thrust.

Finding as to Risk

1. There is no requirement to include the Beta light call as part of the pre-landing briefing. Briefing this item would remind the pilots of the need to confirm Beta light activation for both engines before application of thrust reverse.

Safety Action Taken

Perimeter Aviation Ltd. has taken action to amend its SA226 standard operating procedures. Crews are now required to arm the nosewheel steering system during the pre-landing checks. Flight crews were advised of the change and the appropriate training manuals were amended. This action also satisfies Transport Canada Airworthiness Directive 2003-24R1, which cautions that a freely castering nosewheel during landing on a soft, unpaved, snow-covered or contaminated runway may result in unstable nosewheel castering with associated loss of control.

Perimeter Aviation Ltd. has indicated that it is in the process of revising training procedures to ensure the importance of waiting for Beta light activation on both engines before application of thrust reverse is clearly understood. Wording in company operations procedures will be fortified to support this requirement.

Perimeter Aviation Ltd. is building a flight simulator to provide normal and emergency training. It is intended that asymmetric thrust training will be available.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 December 2007.