AVIATION OCCURRENCE REPORT

UNCOMMANDED GEAR RETRACTION

PERIMETER AIRLINES (INLAND) LTD
SWEARINGEN SA226-TC METRO C-GYRD
WINNIPEG, MANITOBA
06 NOVEMBER 1996

REPORT NUMBER A96C0232

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Summary

Perimeter Airlines Flight 625, a Fairchild SA226-TC Metro II, serial number TC 278, was returning to Winnipeg, Manitoba, after a freight charter flight to Regina, Saskatchewan. The aircraft was operated by a crew of two pilots, and there were no passengers on board. The crew completed a vectored instrument landing system (ILS) approach to runway 36, with the first officer at the controls. The aircraft touched down about 1,200 feet from the threshold and had rolled about 2,000 feet down the runway when the landing gear retracted. The aircraft came to rest on its fuselage on the runway, near the intersection with runway 07/25, about 3,300 feet from the point at which the aircraft touched down. The crew shut down the engines and evacuated the aircraft. No injuries occurred.

Ce rapport est également disponible en français.

Other Factual Information

The captain had a total flying time of about 4,500 hours, of which 70 hours were flown during the previous 30 days. The first officer had about 750 hours of flight time, 70 hours during the previous 30 days. Both the captain and the first officer were certified and qualified for the flight. Both reported that the landing gear was selected down during the approach, that the landing gear selector was left in the down position, and that the indicated hydraulic system pressure was 2,000 pounds per square inch (psi) after the landing gear was extended. The standard company procedure is to extend the landing gear as the aircraft intercepts the glide slope during the approach. Normal hydraulic system pressure is 1,750 to 2,000 psi. The landing gear indicator reportedly showed that all three gear legs were down.

The aircraft was observed to break out of the cloud at about 200 feet above ground level (agl), somewhat to the right of the runway centre line, then manoeuvre into position while descending to the runway. The landing was described by several witnesses as normal. After touching down, the aircraft rolled about 2,000 feet and slowed to an estimated 40 nautical miles per hour before disappearing from the view of the witnesses. The landing gear was reported to be extended during the landing and initial landing roll. Shortly thereafter, all three landing gear legs began to retract, and the aircraft sank to the runway. When the aircraft's propellers struck the runway, they curled back and broke, and several pieces penetrated the aircraft's fuselage, severing a large electrical wiring bundle and some hydraulic lines.

The time of the occurrence was 1251 central standard time (CST). The weather at Winnipeg at 1300 CST was as follows: wind 360° true at 14 knots, visibility one-half statute mile in snow with a vertical visibility of 200 feet, and temperature and dew point both zero degrees Celsius. A surface condition report for 1200 CST indicated that the centre 100 feet of runway 36 was covered with snow and slush to a depth of one-eighth inch, the remainder was covered with two inches snow and slush, and de-icing chemical had been applied. The crew reported that there was slush on the runway at Regina on departure.

The maximum allowable gross weight of the aircraft is 12,500 pounds. The gross weight of the aircraft at take-off from Regina was 11,145 pounds, and its landing weight at Winnipeg was 10,295 pounds. The allowable centre of gravity limits at 10,295 pounds are 256.3 inches to 277 inches aft of datum. The aircraft's centre of gravity at landing was 257.5 inches aft of datum.

The landing gear is actuated by hydraulic pressure. The hydraulic system includes two engine-driven pumps which supply pressurized fluid to a hydraulic power pack. In the power pack, electrically operated valves direct the fluid to the “up” or “down” landing gear lines. The landing gear selector was found in the down position after the occurrence. The aircraft was lifted by cranes, and the left main gear was found in the up-and-locked position, and the right main gear and the nose gear were partially extended. When the landing gear doors and uplocks were released, the landing gear extended easily to the down and geometric over-centre position. The extent of the fuselage hydraulic and electrical damage precluded the application of power to the electrical or hydraulic systems; however, the aircraft was inspected and tested to the extent possible.

The landing gear selector switch and the flap selector switch route 28-volt electricity from the cockpit, along their respective “up” or “down” circuits, to the hydraulic power pack. The electrical circuitry from these switches in the cockpit to the terminal strip in the left engine nacelle was tested, and no discrepancies were

found. However, this circuitry incorporates several connectors between the cockpit and the terminal strip, and an intermittent fault cannot be ruled out. The electrical system incorporates “weight-on” (squat) switches at each gear leg. The weight-on switches are designed to prevent an “up” signal at the cockpit landing gear selector from reaching the hydraulic power pack when the aircraft's weight is compressing the landing gear oleos on the ground. The weight-on and gear selector switches were tested and found to be functional. The landing gear oleo extension was found to be greater than that recommended by the aircraft manufacturer, but still in the range that allowed for proper operation of the weight-on switches.

Examination of the electrical circuitry revealed that the flap and gear wiring harnesses in the left engine nacelle, between the hydraulic power pack cannon connectors and the nacelle terminal strip, had been replaced after the aircraft entered service with this operator. This wiring displayed numerous small areas of bare wiring, where the nylon insulation on the wiring harnesses appeared to have been removed by abrasion. The flap harness was partly enclosed by soft insulating tubing (spaghetti), and the gear harness was wrapped with spiral wrap. Neither harness was attached to the aircraft structure in the portion between the terminal strip and the hydraulic power pack. Some oil contamination was found on the wiring harnesses in the power pack area.

The operator's records indicated that the aircraft was maintained in accordance with existing airworthiness regulations. There was no entry in the records specifically mentioning repair of the wiring harnesses from the terminal strip to the hydraulic power pack. However, an entry dated August 09, 1994, noted that "landing gear control circuit breaker keeps popping; repaired wiring for landing gear hydraulic control valve as per S/B 226 29 008, installed terminal block and relocated diodes for flap and landing gear wiring at power pack."

Bare wiring is subject to short circuits by contact with other uninsulated wiring or conducting material, or from contact with contaminants such as water, oil, slush, or de-icing fluids. Airworthiness regulations do not specify any one particular method of protecting wiring from chafing. However, acceptable engineering practices require that wiring be protected from short circuits resulting from abrasion or contamination. Acceptable practices include tying or clamping wiring to the aircraft structure, or enclosing it in tubing or conduits in areas where abrasion is likely.

The hydraulic power pack was removed and examined at the TSB Engineering Branch in Ottawa (see LP 166/96). No damage to the power pack was noted, and no anomalies were found in its operation. There is no time-before-overhaul limit on the power pack or related wiring in either the operator’s approved maintenance procedures or in the aircraft manufacturer’s requirements. These items are "on condition" systems and do not have to be replaced as long as they are giving satisfactory service. The power pack was manufactured in 1983; however, no record was found of when it was installed on the aircraft or the total time accumulated on the component.

In order for the hydraulic power pack to retract the landing gear after landing, the electrical “down” signal would need to be removed, and an “up” signal applied. The bare wiring in the left engine nacelle is electrically downstream from the landing gear selector. It is also downstream from the weight-on switches in the landing gear. These switches are designed to prevent an “up” signal going to the power pack by an inadvertent selection of the landing gear selector in the cockpit while the aircraft is on the ground.

The accident aircraft is on the Fairchild Phase Inspection Program. The inspection program involves dividing the aircraft inspection into 10 segments referred to as "zones". During the course of an 800-hour cycle, each

zone is scheduled for inspection at least once in a "heavy" and once in a "light" inspection. A light inspection is only a visual inspection, with no panel removal; a heavy inspection is more detailed, requiring panel and access door removal. According to the operator's Transport Canada approved Maintenance Control Manual (MCM), the phase inspections are to be done at 150-hour intervals over a total cycle of 1,200 hours. An objective stated in Section 1 of the Phase Inspection Program is the inspection of the power pack and associated electrical harnesses.

Both the aircraft manufacturer and the MCM require the inspection of each zone to be done in accordance with check sheets. In the case of heavy inspections, panel diagrams are incorporated. According to the panel diagram, zone 5 comprises the landing gear and wheel wells, while zone 9 comprises the engines. However, the zone 9 panel diagram includes not only the engines but the entire nacelle, which is outside of the wheel well. The check sheets indicate that a heavy inspection of zone 5 requires the removal of 11 access panels but does not require that the hydraulic power pack transmitter access panel be removed; in fact, the transmitter access panel is not identified. The check sheets state that the power pack area is to be inspected through panel 551 in the forward wheel well area. However, there is no specific mention of a requirement to check the power pack's associated electrical harnesses or the terminal strip and diodes. It is difficult to inspect the condition of the power pack through the wheel well panel; a complete inspection, including inspection of the electrical components, requires the removal of the transmitter access panel.

For a heavy inspection of zone 9, the check sheets require the removal of panels 958 and 959, but these panels are not illustrated. The zone 9 inspection sheets require the inspection of certain items which are accessible only through the transmitter access panel located below the power pack area.

The following Engineering Branch report was completed:

LP 166/96 - Hydraulic Power Pack and wiring.

Analysis

The aircraft's weight and centre of gravity were within approved limits during the accident flight. The aircraft's electrical and hydraulic systems apparently functioned normally during the flight, until the aircraft landed at Winnipeg.

Although the crew shut down the aircraft's engines as soon as the aircraft sank to the runway, pieces of the propellers broke off and penetrated the fuselage, disrupting electrical cables and hydraulic lines.

The crew and witness reports indicate that the crew selected the landing gear down during the approach, and that the gear extended to the down position well before the aircraft landed. The distance travelled by the aircraft on its landing gear and its reduction in speed during that time make it likely that the aircraft's weight was substantially on the landing gear before the gear retracted after landing. The serviceability of the landing gear weight-on switches and oleo extension make it unlikely that the hydraulic power pack received an "up" signal from the landing gear selector in the cockpit after the aircraft touched down.

Part of the flap wiring harness at the terminal strip was enclosed by soft plastic tubing, and the gear harness in that area was wrapped with spiral wrap; however, these measures did not adequately protect the wiring, and the

wiring sustained abrasion damage as a result. Although these measures did not contravene existing regulations, they did not meet the standards of acceptable engineering practices.

The most likely accident scenario is that the hydraulic power pack received an electrical “up” signal and lost its normal electrical “down” signal, which resulted in the retraction of the landing gear. The serviceability of the landing gear and the electrical circuitry leading to the terminal strip indicate that the most likely source of the electrical “up” signal was the area between the terminal strip and the hydraulic power pack containing bare electrical wiring for the landing gear and flap systems. The oily condition of this wiring, together with the wet, slushy runway conditions at Winnipeg and Regina and the use of chemical de-icing fluids, increased the likelihood of electrical short circuits in the area of the terminal strip and the power pack connectors.

Although the Fairchild inspection sheets require the removal of 11 panels to complete the zone 5 heavy inspection, they do not identify or refer to the hydraulic power pack transmitter access panel. The extensive detail contained in the sheets and panel diagrams suggests that the procedures contained therein are sufficient to accomplish the inspection, and that further inspection and panel removal is not required. However, the procedures contained in the zone 5 check cannot adequately accomplish the objective, stated in Section 1 of the Phase Inspection Program, of inspecting the condition of the power pack and associated electrical harnesses without the removal of the transmitter access panel. Because the components involved are "on condition" with no mandatory replacement interval, inspection of the area is unlikely to occur under the existing inspection program until a component fails.

The inspection procedures outlined in the manufacturer’s Phase Inspection Program and the MCM, in referring to panels which are not illustrated and in requiring the inspection of items which are not accessible by following the listed procedures, are ambiguous and reduce the effectiveness of the inspections.

Findings

1. The crew was certified and qualified for the flight.

2. The aircraft's weight and centre of gravity were within approved limits throughout the accident flight.

3. The crew selected the landing gear down during the approach, and the gear was extended before the aircraft landed.

4. The aircraft rolled on the landing gear wheels for about 2,000 feet on runway 36 before the gear began an uncommanded retraction.

5. The aircraft records indicate that the aircraft was certified and maintained in accordance with existing regulations.

6. It is unlikely that the hydraulic power pack received an "up" signal from the landing gear selector in the cockpit after the aircraft touched down.

7. The electrical wiring harnesses of the landing gear and flap systems between the left nacelle terminal strip and the hydraulic power pack had numerous small areas of chafed insulation, exposing bare wiring.

8. The repairs that had been made to the wiring harnesses after the aircraft entered service with the operator did not adequately protect the harnesses from chafing and were not in accordance with acceptable engineering practices.

9. The wet, slushy conditions at the departure and landing runways and the oily condition of the wiring harnesses were conducive to electrical faults in unprotected wiring.

10. The manufacturer’s Phase Inspection Program and the operator’s approved maintenance program are ambiguous and do not clearly require the inspection of the hydraulic power pack or its wiring harness area.

11. Parts of the propeller blades penetrated the fuselage and disrupted the electrical and hydraulic systems.

Causes and Contributing Factors

The landing gear began an uncommanded retraction after landing, most likely as a result of one or more electrical short circuits in the landing gear and flap wiring harnesses in the area of the hydraulic power pack. Contributing to the electrical faults were the ambient environmental and runway conditions, the inadequate wiring protection provided by a repair of the wiring harnesses, and the ambiguous procedures in the manufacturer's and operator's inspection programs.

Safety Action Taken

In January 1997, the operator revised the Zone 5 Heavy Inspection sheets. The revision includes the following additions: "Heavy Zone 5L, item No.3: Remove panel below power pack. Inspect wiring for condition. Note: If area below power pack is dirty, Varsol wash prior to inspection."

Newer Fairchild Metro aircraft are equipped with composite shields on the fuselage next to the propellers for ice protection, and Kevlar blankets inside the fueselage for shrapnel protection. The incorporation of these shields and blankets reportedly reduces the likelihood that detached propeller blade sections will penetrate the aircraft fuselage.

In an effort to clarify the Phase Inspection Manual P/N 27-10054-031 with respect to inspection procedures, Transport Canada (TC) advises that it will request Fairchild to amend Form 2.609 of the Zone 9 inspection requirements to identify the locations of panels 958 and 959. Additionally, TC will ask Fairchild to determine if the power pack's electrical harness, terminal strip and diodes should be identified as items to be inspected through panel 959.

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 23 December 1997.