Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A12O0005

RUNWAY OVERRUN

AIR BRAVO CORPORATION
PILATUS PC-12/45 C-FPCN
TIMMINS/VICTOR M. POWER AIRPORT, ONTARIO
15 JANUARY 2012

Canada

Aviation Investigation Report

Runway Overrun

Air Bravo Corporation
Pilatus PC-12/45 C-FPCN
Timmins/Victor M. Power Airport, Ontario
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Report Number A12O0005

Synopsis

A single-engine Pilatus PC-12/45 aircraft (serial number 258, registration C-FPCN) operating as Air Bravo flight 1203 departed Hornepayne, Ontario, at 2140 Eastern Standard Time in instrument meteorological conditions. The flight crew, consisting of 2 pilots and a flight paramedic, were returning with the aircraft to Timmins after a day of patient transfer flights and an aircraft change in Thunder Bay. Approximately 60 nautical miles from the Timmins Airport at 15 000 feet above sea level, the engine torque was indicating below the normal operating range. This was followed over the next couple of minutes by illumination of the amber oil pressure caution light, the red low oil pressure warning light, and the chip detector warning light, as well as the appearance of oil on the windscreen. The flight crew reduced engine power, declared an emergency, and requested a straight-in approach to Runway 10 at Timmins. The aircraft landed long and fast, became airborne again and then touched down approximately 1200 feet beyond the runway end in about 2 feet of snow. The aircraft slid about 300 feet and came to a stop on a heading almost 90° to the left of runway orientation. The crew were uninjured. The aircraft sustained substantial damage.

Ce rapport est également disponible en français.

Other Factual Information

History of Flight

The flight crew initially departed Timmins at 1115[1] in C-FPCI, another Pilatus PC-12/45 operated by Air Bravo Corporation (Air Bravo), with a flight routing of Timmins, Moosonee, Thunder Bay, Hornepayne and return to Timmins, Ontario. Upon arrival in Thunder Bay the flight crew were advised that C-FPCI would remain in Thunder Bay for some maintenance that could not be performed in Timmins. The flight crew was re-assigned to aircraft C-FPCN; the aircraft was fuelled and a pre-flight inspection was carried out. During the pre-flight inspection the oil level was checked and found to be within limits and no defects were noted. The flight from Thunder Bay to Hornepayne was uneventful and no problems were noted throughout the flight.

The aircraft departed Hornepayne and climbed to a cruising altitude of 15 000 feet above sea level (asl) where the torque was set to 29.0 pounds per square inch (psi). The first officer (FO) was the pilot flying. Approximately 20 minutes after departure, when the aircraft was 60 nautical miles (nm) from the Timmins Airport, the engine torque dropped to 11.5 psi. Several minutes later the engine instrument system (EIS) amber CAUTION light illuminated along with a blinking oil pressure indication. At this point the captain took control of the aircraft, reduced engine power and the low oil pressure checklist was completed. Moments later the EIS red WARNING light illuminated along with the blinking oil pressure light and the chip detector light, and oil droplets covered the windscreen. The flight crew declared an emergency and requested a straight-in approach to Runway 10 at the Timmins Airport. The flight crew elected to remain at 15 000 feet asl as long as possible to ensure they were well within gliding distance of Runway 10 in the event of a complete engine failure. According to the aircraft flight manual the aircraft can glide approximately 40 nm from an altitude of 15 000 feet.

Radar data shows the aircraft starting to descend at 2214:18, approximately 28 nm from the threshold of Timmins Runway 10. The aircraft descended at an average rate of 1775 feet per minute from the cruise altitude down to 7900 feet asl. During this 4-minute descent the aircraft travelled 18 nm at a ground speed of 270 knots. The pilots controlled both the rate of descent and the airspeed by side slipping the aircraft. The pilots could not see the runway until the aircraft was below 8000 feet asl due to the oil on the windscreen and the weather conditions. The runway was visible only through the side windows.

Radar contact with the aircraft was lost when the aircraft was at 6500 feet asl, 8.5 nm from the runway and traveling at a ground speed of 239 knots. The captain slowed the aircraft during the remainder of the approach by lowering both the landing gear and the flaps. The average speed on descent was 170 knots. At approximately 2221 the aircraft touched down about one-third of the way down Runway 10. The aircraft's speed at touchdown was estimated to be 130 knots indicated airspeed (IAS). The approach speed for flaps 40 was 84 knots; normal landing speed with flaps 40 is approximately 70 knots. Full braking was applied. The aircraft engine was shut down and the propeller was feathered when the crew realized they would not be able to stop on the runway. The aircraft became airborne again and continued 1200 feet past the end of the

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1 All times are Eastern Standard Time (Coordinated Universal Time minus 5 hours)

runway before touching down in the snow and sliding to a stop. Airport personnel contacted fire response services by a 911 call.

Wreckage Information

The overrun occurred under control in a wings-level attitude. Both wings were damaged from the wing root outboard to the wing tips, including the flaps. The nose gear and nose gear doors were also damaged, and both main wheels had multiple flat spots worn through several layers of chords in the tires. The fuselage and cabin area remained intact with very little damage except for the wing carry-through structure.

Weather

The reported weather for Timmins at 2200 was as follows:

- wind 170° True (T) at 10 knots gusting to 15 knots;
- visibility 15 statute miles;
- few clouds at 4500 feet above ground level (agl), broken cloud at 8500 feet agl and overcast cloud at 14 000 feet agl;
- temperature -10°C, dew point -13°C and the altimeter setting 30.15 inches of mercury.

While on approach, the winds given to the crew were 190° magnetic (M) at 10 knots, gusting to 15 knots.

Airport

The Timmins/Victor M. Power Airport (CYTS) is located approximately 5 nm north of the city of Timmins in a remote area of northern Ontario. The airport is situated at a field elevation of 968 feet asl and has the following runways:

- Runway 10/28, which is 4907 feet long and 150 feet wide; and
- Runway 03/21, which is 6000 feet long and 150 feet wide.

Runway 03 is equipped with an ILS/DME [2] approach while the remaining runways (10, 28 and 21) have both VOR/DME [3], and RNAV [4] approaches. Timmins is staffed by a flight service specialist. Because no crash, fire, and rescue services are situated on the airfield, airport emergency services are provided by the City of Timmins and initiated by a 911 call.

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2 Instrument approach requiring both an instrument landing system and distance-measuring equipment.

3 Instrument approach requiring a very high frequency, omnidirectional range with associated distance-measuring equipment.

4 Instrument approach based on area navigation (RNAV) using a global navigation satellite system (GNSS).

Pilot Information

The captain was certified and qualified for the flight in accordance with existing regulations. The pilot-in-command (PIC) held an airline transport pilot license valid for single- and multi-engine land and sea planes as well as a group 1 instrument rating. He had a total flight time of approximately 3000 hours, with 200 hours on the PC-12/45. He received his initial PC-12/45 training at Air Bravo in October 2011; it included simulator training.

The first officer (FO) was certified and qualified for the flight in accordance with existing regulations. The FO held a commercial pilot license valid for single- and multi-engine land planes as well as a group 1 instrument rating. He had a total flight time of approximately 1530 hours, with 350 hours on the PC-12/45. He received his initial PC-12/45 training at Air Bravo in July 2011.

Aircraft

The aircraft was operated by Air Bravo and was used mainly for air ambulance work under contract with Ornge.[5] The aircraft was originally based in Thunder Bay, but was being moved to Timmins on the day of the occurrence. The aircraft, powered by a single Pratt & Whitney Canada PT6-67B, twin-shaft turboprop engine was maintained on a Transport Canada–approved customized progressive inspection program derived from the Pilatus progressive inspection program. The program consists of 6 mini-inspections and 6 phase inspections conducted on an alternating basis every 100 hours. After 1200 hours all inspections have been completed and the cycles start over again.

A mini-inspection of the aircraft was completed in Thunder Bay 1.4 hours before the occurrence. The mini-inspection consisted of a visual inspection of the wing, tail, fuselage, and landing gear. Fluid levels were verified and the aircraft was visually inspected for fluid leaks. A visual inspection of the cabin and cockpit was performed to check cleanliness, seats and seat belts. A visual inspection of the propeller was performed, and the engine oil and fuel filters were examined.

The aircraft was equipped with a brake system that does not incorporate an anti-skid system.

The aircraft was not equipped with a cockpit voice recorder (CVR) or a flight data recorder (FDR); neither is required by regulation.

Engine

On 18 December 2011, Air Bravo removed a leased engine (serial number PCE-PR0115) and installed the occurrence engine (serial number PCE-PR0256), a spare owned by Air Bravo. This included swapping over several components and mounts from the previous engine to the new one. In accordance with standard practices, an independent inspection of the engine was carried out by another qualified aircraft maintenance engineer to ensure the integrity of the installation and to confirm the static rigging of the engine controls. No faults were found. Engine runs,

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5 Ornge (formerly Ontario Air Ambulance) is the air ambulance service for the province of Ontario and the Ontario Ministry of Health and Long-Term Care.

along with appropriate leak checks, were performed following the replacement, with no faults found. In addition, the reduction gearbox chip detector was checked daily for a period of a week. At the time of the accident the engine had accumulated approximately 97 hours since replacement.

An inspection of the engine following the accident showed that the B nut on a 90° fitting attached to the oil outlet male union on top of the torque limiter was completely disconnected. Normally the engine contains 13.6 litres of oil. Less than a litre of oil was left in the engine. As well, 2 sets of clamps were missing from the associated plumbing (Photo 1). The magnetic chip detector was removed and found to be completely covered in ferrous material. The oil filter was removed and found to be covered in both ferrous and non-ferrous material.

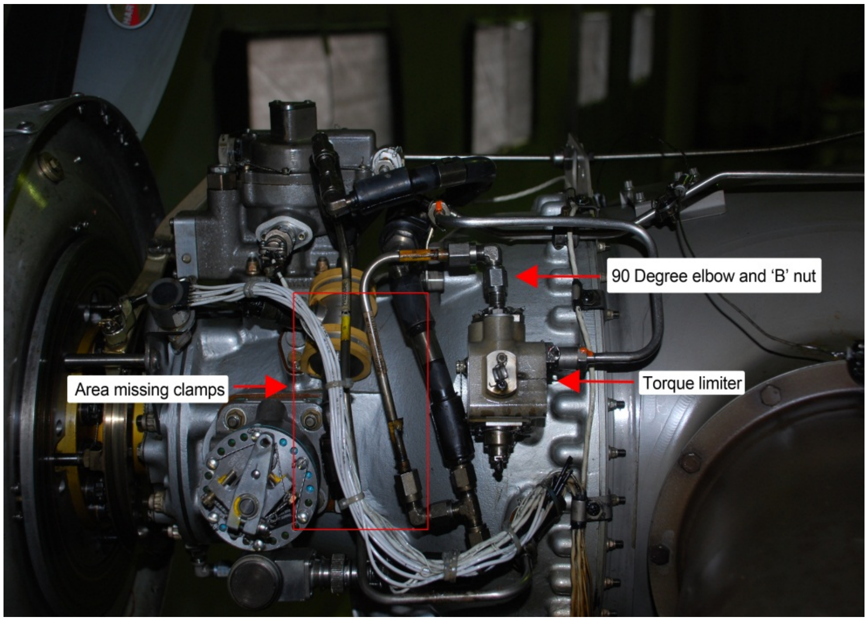

Photo 1. B nut, indicating the area missing clamps

The torque limiter is part of the torque pressure control and indicating system, and uses the engine oil as part of this function. This particular area was subject to Pilatus Service Bulletin (SB) 71-007 and European Aviation Safety Agency (EASA) Airworthiness Directive (AD) 2007-0235, which required the replacement of the torque oil-pressure pipes and hoses with new parts to increase the clearance and reduce the likelihood of chafing, which had led to engine oil leakage in some aircraft. These also required a change to the clamping arrangement in the affected area. All of the PC-12/45 aircraft operated by Air Bravo had complied with this service bulletin.

Generally, parts supplied by the engine manufacturer for use on the engine have some means of attaching a secondary locking device, whether it is lock wire, cotter pins, self-locking nuts or tab washers. This is not true for the parts supplied by the airframe manufacturer for use on the engine. The oil pipes and hoses affected by the SB and AD are parts supplied by the airframe manufacturer. These hoses and pipes, including the affected B nut, do not have any means of attaching a secondary locking device; in contrast, all of the engine fittings, including the male union on the torque limiter, are lock wired.

Subsection 571.02 (1) of the *Canadian Aviation Regulations* (CARs) states:

> Subject to subsection (2), a person who performs maintenance or elementary work on an aeronautical product shall use the most recent methods, techniques, practices, parts, materials, tools, equipment and test apparatuses that are

(a) specified for the aeronautical product in the most recent maintenance manual or instructions for continued airworthiness developed by the manufacturer of that aeronautical product;

(b) equivalent to those specified by the manufacturer of that aeronautical product in the most recent maintenance manual or instructions for continued airworthiness; or

(c) in accordance with recognized industry practices at the time the maintenance or elementary work is performed.

CARs 571.06 and 571.08 go into further detail on how work should be performed on the aircraft. Neither the aircraft maintenance manual nor the SB and AD specify a torque value for any pipe or hose fittings on the aircraft; they simply instruct that fittings be tightened. Standard torque values not specifically identified in the published instructions for continued airworthiness must therefore be obtained from a source that meets the requirements of CAR 571.02 acceptable data. In this case, the latest version of the Federal Aviation Administration's Advisory Circular (AC) 43.13 [6] is commonly used to determine such values and is considered acceptable data. However, the general industry practice is simply to tighten the fittings without applying a specific torque.

Both the B nut on the 90° elbow and the male union from the top of the torque limiter showed signs of galling on their cup-and-cone mating surfaces. Galling is an indicator that the fittings had been previously subjected to excessive torque. Once galling has occurred, proper torque values may be difficult to maintain due to a lack of proper contact area between the mating surfaces.

Torque Seal Inspectors Lacquer™ (torque seal) is a special paint that can be applied to fasteners or parts after they have been properly tightened. It dries brittle and will crack to provide a visual indication that a part or fastener may have become loose. Torque seal was neither used in this area nor was it required by regulation, maintenance procedure, or practice.

Previous Occurrences

In 2009, there was an occurrence involving another Canadian-operated Pilatus PC-12/45 on which the same fitting loosened in flight and the aircraft began to lose oil (A09C0034). The aircraft diverted and landed without incident. This fitting had been loosened and re-tightened during a stall warning/stick-pusher system check 201 hours prior. It was also noted that this installation was not clamped as per the SB and AD. The TSB did not conduct a full investigation into this occurrence; however, investigators did examine the engine and the parts were sent to the TSB Laboratory for further examination (LP045/2009). The examination showed the parts met all the requirements for the applicable material and design standards, but it found galling on the cup-and-cone mating surfaces. It was concluded that the damage was likely caused by over-tightening of the parts at some time in the past.

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6 This manual is used by aircraft maintenance technicians in Canada and the United States as a reference guide for best practices.

Emergency Procedures

The PC-12/45 *Aircraft Flight Manual* (AFM), section 3.6, Engine Emergency Procedures, contains a number of engine-related emergency procedures. Section 3.6.1, Oil Pressure, has two levels of warning that call for the following actions when the oil pressure is outside of the normal operating range of 90 to 135 PSI:

> Engine Instrument System (EIS) amber Caution oil blinking 40/min (after 20 seconds, EIS warning oil blinking 80/min. Oil pressure of 60-90 PSI):
>
> | | |
> |---|---|
> | NG | Check above 72% |
> | Torque | Reduce to below 24 PSI |
> | Aircraft | Land as soon as practical. [7] |
>
> Indications: EIS caution oil blinks 40/min and/or EIS warning oil blinks 80/min. Oil Px below 60 PSI or above 135 PSI:
>
> | | |
> |---|---|
> | Aircraft | Land as soon as possible [8] using minimum torque. If possible always retain glide capability to the selected landing area in case of total engine failure. |

In addition, section 3.6.3, Oil Contamination Chip, states in part:

> Indication: Central Advisory and Warning System (CAWS) caution CHIP
> B. Inflight
> 1. Check and monitor engine parameters.
> 2. Reduce power to minimum required for safe flight
> 3. Land as soon as practical
>
> After landing:
> 4. Inspect chip detector(s) and engine, if required.

The PC 12/45 Procedures, Speeds and Limitations, section 2.02, carried on board the aircraft, is a quick reference guide that contains various limitations and emergency procedures taken from the AFM. Page 4 contains the emergency procedures for an oil pressure emergency and mirrors the AFM; however, there is no section for an oil contamination chip annunciation.

Training

Pilots at Air Bravo go through a training program covering a range of topics which includes company standard operating procedures, type-specific ground school, and type-specific flight and simulator training. The flight and simulator training covers a wide range of normal and emergency flight procedures in a controlled environment. The *Air Bravo Training Manual*, section 5.13.2 states, "Any simulated failures of aeroplane systems shall only take place under operating conditions which do not jeopardize safety in flight (see 5.27 Safe Training Practices)." In this type of training, aircraft failures are normally given by verbal cues: a flight crew might

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[7] Pilatus defines land as soon as practical: Landing airport and duration of flight are at the discretion of the pilot. Extended flight beyond the nearest suitable airport is not recommended.

[8] Pilatus defines land as soon as possible: Land without delay at the nearest airport where a safe approach and landing is reasonably assured.

be told they just received a caution or warning and they have to react appropriately to the given problem. When the pilots go to the simulator for training, aircraft failures and emergencies can be fully simulated, and the instructor can observe the crew's interaction and how they deal with a given problem. Most of this training is based on scripted scenarios where the flight crew take off from an airport and are assigned a problem or multiple problems to deal with during the flight. Although crew training deals with a large variety of simulated failures, including engine failures and forced approaches, neither crew member had ever dealt with managing an emergency in conditions similar to those experienced during this flight.

The following TSB Laboratory report was completed:

LP022/2012 – Examination of Torque Limiter Fitting

Analysis

The initiating event in this occurrence was the loosening of a B nut on the 90° fitting attached to the oil outlet on top of the torque limiter. This allowed all useable engine oil to be pumped overboard in a short period of time. Several hypotheses were considered to determine how the B nut could have become loose, including the following:

- Galling on the mating surfaces prevented proper tightening of the B nut.
- The B nut was incorrectly installed during the engine installation.
- There was vibration in the oil lines due to the missing clamps, which caused rotational movement of the 90° fitting.

It could not be positively determined how the fitting became loose. It may have been any or a combination of all of these hypotheses but the end result was that a single point failure on the engine led to a complete and sudden loss of all the engine oil.

A secondary locking device such as lock wire can prevent fittings like the B nut from backing off even if it is installed incorrectly. The application of torque seal can provide a visual clue that the fitting has become loose.

The flight crew's first indication of the problem came just moments before they would have started their regular descent checks for the approach to Timmins. Anticipating that the engine might fail due to a lack of oil, the captain delayed the descent into Timmins to ensure the aircraft could glide to the airport if the engine were to fail completely. When they began the descent to Timmins, they were 28 nm from the airport at 15 000 feet asl, well within the 40 nm gliding distance.

Both flight crew members were experienced and qualified for the flight in accordance with existing regulatory requirements. Both had completed all the required training several months before the incident. However, their training did not cover the specific scenario of a possible engine failure in night/instrument flight rules conditions with an obscured windscreenand neither crew member had experienced an actual engine-failure emergency before.

The crew concentrated on the single goal of getting the aircraft down onto the runway as quickly as possible, and as such became fixated on the straight-in approach and landing on Runway 10, which was directly in front of them. Runway 10, though, was the shorter runway and the aircraft would be landing with a 90° cross wind, in contrast to Runway 21, the longer runway, which the winds were favouring. The crew's focus was likely intensified by their concern that the engine could fail at any time and that they could not see the airport because of the combination of oil on the windscreen, cloud layers, and the dark night, resulting in a very fast approach and landing. Because there was no CVR on the aircraft, the investigation could not fully assess the crew's interactions during the approach.

The average ground speed in descent to the runway was 170 knots. The crew estimated that they touched down at 130 knots, about 60 knots higher than the normal 70-knot touchdown speed with full flap (flaps 40). Application of full brake without the use of engine reverse was not sufficient to stop the aircraft before the end of the runway. The aircraft became airborne again at the end of the runway, possibly from the captain pulling back on the controls. The aircraft traveled an additional 1200 feet before landing again in the snow and sliding to a stop.

The flight crew did not manage the final approach and landing speed effectively, resulting in the aircraft touching down long and fast and overrunning the runway.

Findings

Findings as to Causes and Contributing Factors

1. For undetermined reasons, the B nut fitting on the oil outlet of the torque limiter became loose, causing a complete loss of engine oil.

2. The flight crew did not effectively manage the final approach and landing speed, resulting in the aircraft touching down long and fast and overrunning the runway

Finding as to Risk

1. Lack of a secondary locking device or visual indication of fittings becoming loose increases the risk of critical components loosening in flight, jeopardizing the continued safe operation of the aircraft.

Safety Action Taken

Operator

The operator carried out a safety management system investigation following the incident, which highlighted the same issues as this investigation. As a result of its internal investigation the company developed several new procedures for the maintenance and flight operations departments. Maintenance now requires any fitting on the engine without a means of attaching a secondary locking device to have the fitting torqued using standard values in the latest version of the AC 43.13. Once torqued, the fitting is to be inspected by another aircraft maintenance engineer for correct torque and torque seal is to be applied to the fittings. Flight operations have written a new scenario for simulator training to mirror the conditions of this occurrence and evaluate how flight crews deal with a similar one.

Pilatus Aircraft Ltd.

The type of pipe connections involved in the occurrence are used on all Pilatus fuel and hydraulic lines. Based on Pilatus field experience with several million flight hours these connections never created specific issues except in the two events in Canada. Therefore is Pilatus' position is that this type of installation is adequate.

However, Pilatus recognizes that such connections are not normally subject to opening/closing on a regular basis for system checks, as was the case in this occurrence, and as a result it has started a feasibility study aiming at improving the current installation without creating new hazards.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 March 2013. It was officially released on 14 March 2013.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.