BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

www.bea.aero

REPORT
ACCIDENT

Loss of control in icing conditions, in-flight breakup, collision with the ground

Aircraft	Aircraft Pilatus PC-12/47 registered HB-FPZ
Date and time	24 August 2012 at around 16 h 00[1]
Operator	Air Sarina
Place	Solemont (France)
Type of flight	General aviation, Business
Persons on board	Pilot and three passengers
Consequences and damage	Pilot and passengers fatally injured, aeroplane destroyed

[1]Except where otherwise indicated, times in this report are UTC.

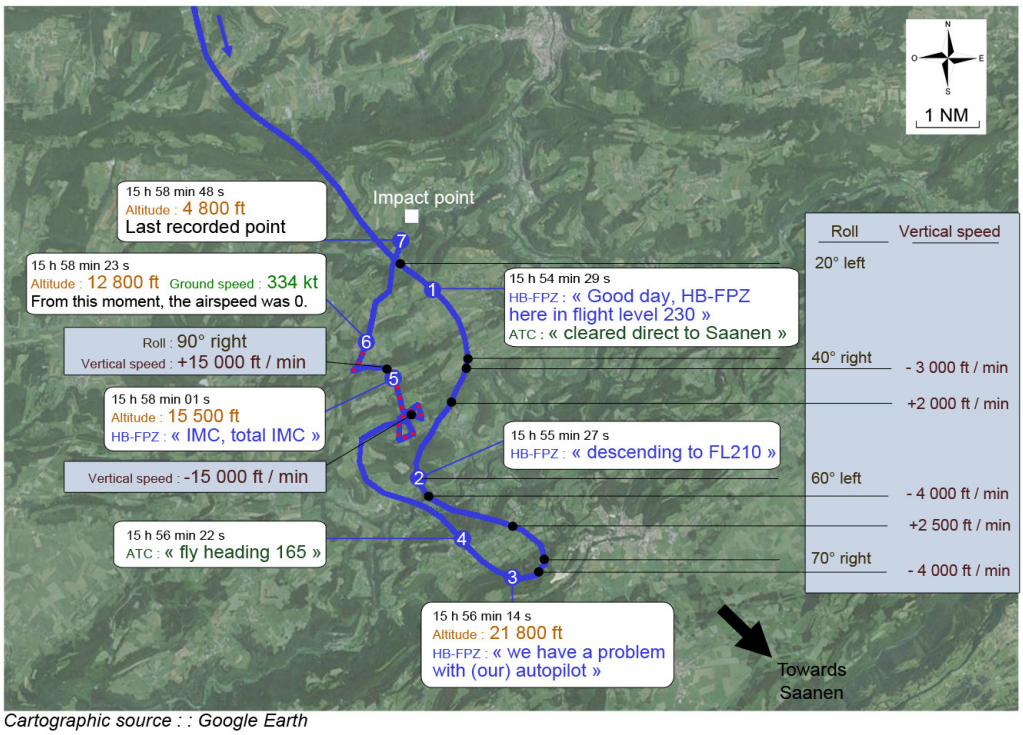
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

1 - HISTORY OF FLIGHT

The pilot took off from Anvers (Belgium) at around 14 h 40 bound for Saanen (Switzerland) where he was supposed to drop off his three passengers. The flight was performed in IFR then VFR, at a cruise altitude of 26,000 ft.

After about 1 h 15 min of flight, still under IFR, the Geneva controller cleared the pilot to descend towards FL 210 and to fly towards Saanen with a view to an approach. A short time later, the radar data showed that the aeroplane deviated from the planned trajectory. Following a question from the controller, the pilot said he had an autopilot problem. The controller then asked the pilot to follow heading 165°, which the pilot read back, then asked him *''are you okay, okay for the safety, it's good for you? ''*. The pilot answered that he had a *''big problem''*. The radar data show tight turns on descent. During these manœuvres, in reply to a request from the controller, the pilot said that he was in *''total IMC''*. During this communication, the aeroplane's overspeed warning could be heard. The aeroplane was then descending at 15,500 ft/min. About ten seconds later, it was climbing at 15,500 ft/min. The right wing broke off about twenty seconds later. The indicated airspeed was then 274 kt and the altitude was 12,750 ft.

The wreckage was found in woods in the commune of Solemont (25). A piece of the right wing was found about 2.5 km from the main wreckage. Some debris, all from the right wing, was found on a south-west/north-east axis. The aeroplane part that was furthest away was found 10 km from the main site.



Cartographic source : : Google Earth

Partial flight path of HB-FPZ based on La Dole radar data from 15 h 53 to last recorded point

Aircraft in overspeed

Times given are UTC

BEA

2 - ADDITIONAL INFORMATION

2.1 Examination of the Wreckage

Examinations made at the site of the accident and on the wreckage established the following facts:

- the aeroplane struck the ground at an indicated airspeed of 305 kt (marking on the airspeed indicator) and with a nose-down attitude of around 80°;
- a part of the aeroplane's right wing broke in flight and separated from the rest of the airframe;
- the flight controls were continuous at the time of the in-flight breakup;
- the right wing front spar failed in overload and showed no previous damage;
- the condition of the clutches on the autopilot in the three axes indicated that the latter was probably disconnected at the time of the collision with the ground;
- the violence of the collision meant that the occupants stood no chance of survival.

In addition, a spectral analysis of the communications with the controller made it possible to state that the engine was functioning nominally.

2.2 Pilot Information

The pilot held a professional pilot's licence from May 2005. He had flown on the PC-12 since May 2004 and had obtained his IFR rating in 2005. In addition, he was a qualified instructor (aeroplane and mountain flying) and examiner (aeroplane).

The pilot's experience was as follows:

- 5,971 flying hours, of which 5,691 flying hours as captain;
- 1,785 flying hours on PC-12;
- 1,226 flying hours in IFR.

An acquaintance, also a pilot, stated that the pilot was comfortable with the use of automatic systems as well as manual flying and described his flying as *"smooth on the controls"*. He was very well aware of how weather radar worked and always chose to fly well wide of storm cells.

The investigation could not determine the actual experience of the pilot in terms of flight in IMC. He was declared flightworthy at the time of the last flights to extend his type and instrument ratings. He failed only one part of the extension of his instrument flight rating in 2007. The failure was linked to a lack of training on approaches.

2.3 Meteorological Information

When the pilot was cleared to descend by the Geneva controller, the aeroplane was flying in a stormy area.

The valid TEMSI EUROC chart at 15h contained the following information on the accident area:

- a cloud layer extending from 3,000 ft to FL 400;
- cumulonimbus in the mass whose peaks reached FL 400;
- rain and hail showers;
- moderate icing between FL 130 and 230;
- 0° isotherm at FL 130.

The TEMSI France chart indicated that the pilot crossed some areas of rain during the climb after takeoff from Belgium.

The forecast messages and observations at aerodromes close to the route followed mentioned storms, precipitation and cumulonimbus.

The analysis made by Météo France after the accident mentioned the existence of areas with severe icing along the Jura, associated with the presence of convective cells. It also mentioned *"a very humid, even saturated atmosphere"*. The severe icing zone covered the accident area.

Note:

- The distribution of the debris from the right wing was consistent with the wind direction at the moment of the accident.
- The aeroplane is certified for flight in known icing conditions. It was equipped with weather radar and a de-icing system. The investigation was not able to determine the working condition of these systems at the time of the accident.

An acquaintance of the pilot stated that he was used to using digital equipment to consult meteorological information. The investigation was not able to determine what information the pilot had at his disposal in order to prepare and undertake his flight.

2.4 Other Events

- Failure of the autopilot on HB-FPZ
  - The pilot had informed Pilatus that during an ILS approach on autopilot a few days previously, the aeroplane suddenly veered to the left. The pilot then disconnected the autopilot and continued the approach without difficulty. The aeroplane was supposed to be taken to Pilatus on the Monday following the accident to be examined there. The pilot had not reported any other autopilot problems.
- Roll control difficulties on a PC-12 in Canada
  - Pilatus was notified of an incident that occurred in February 2012 in Canada. Just after takeoff, the pilot flew for about fifteen minutes in intense rain, before being cleared to climb and start cruise at FL 260. The pilot then noticed slight oscillations in roll and pitch attitude. Thinking that there was an autopilot problem, he disconnected it. Taking back control, the pilot noticed that flying with roll inputs required significant efforts, as if the autopilot had remained connected. Flying in pitch was normal. The use of all possible means to disconnect the autopilot, including the circuit-breaker, remained ineffective on the stiffness noted on the roll control. An attempt to reconnect the autopilot triggered illumination of a warning on the functioning of the autopilot in the roll axis.
    During the descent, roll flying returned to normal on passing through 5,000 ft, while the outside air temperature was -1° c. The flight continued without further incident.
    On the ground, some humidity was found at the level of an aileron control rod guide. The stiffness in roll control was then attributed to icing of the water present on this equipment when the aeroplane was flying in colder air.

Tests performed on the ground by Pilatus showed that when water infiltrated this area and froze, the efforts required to move the ailerons were increased by about 31 N. In flight at an indicated airspeed of 180 kt, these efforts were 97 N, which remains lower than the limit of 222 N laid down by the certification for a temporary effort.

2.5 Aircraft Flight Manual

The aircraft flight manual specifies, in section 2 Limitations, part Severe icing conditions, that when the flight takes place in known icing conditions, *"care must be taken when using the autopilot that tactile cues, such as increased aileron forces, are not masked by the autopilot function. Periodically disengage the autopilot to check for abnormal forces."* The manual also indicates that *"continued autopilot operation is prohibited following abnormal operation or malfunctioning prior to corrective maintenance."*

The manual states that in case of autopilot malfunction, disconnecting it may generate significant efforts. The latter can be compensated for by manual trim inputs.

The manual also specifies that the use of the autopilot is forbidden following abnormal functioning or a failure of the latter and until corrective maintenance intervention has been undertaken.

It was not possible to determine if the pilot knew of and was aware of this information.

2.6 Data Available

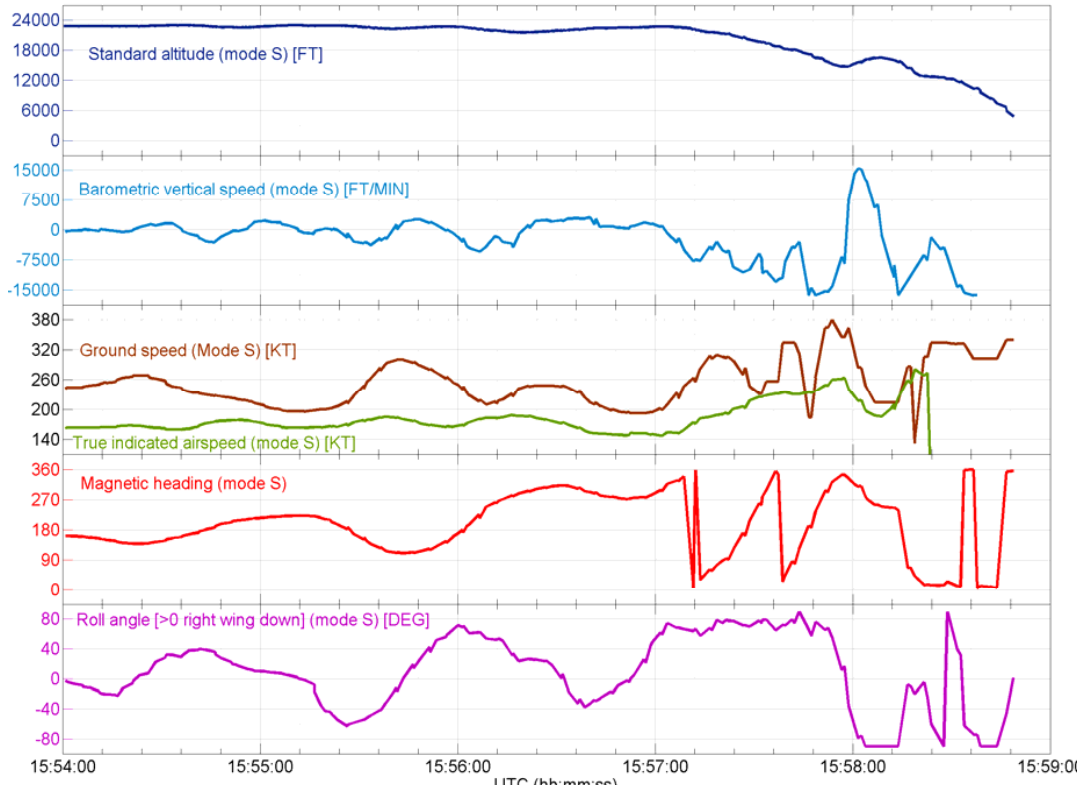
The aeroplane was not equipped with flight recorders, the latter not being required by the regulations.

It was equipped with EGPWS and CAWS (Central Advisory and Warning System) that could record warnings and some flight parameters. Their complete destruction during the accident made it impossible to extract any data from them.

The aeroplane was also equipped with an enhanced mode S transponder. Basic mode S makes it possible to transmit the aeroplane's identification, altitude and transponder code. Enhanced mode S also transmits flight parameters measured by the aeroplane's instruments (specifically, indicated airspeed, roll, vertical speed and magnetic heading).

As of the date of the accident, this extended data was not processed in real time by French radar. In France, radars are able to perform enhanced surveillance, receiving the heading, speed, route, roll and the aeroplane's selected altitude parameters. This capability is however only activated on radar for tests and studies. The limitation in current bandwidth in the DSNA's communication network does not allow general activation of these capabilities. This is planned for the end of 2015. From that date, enhanced surveillance data will then be centralised and recorded.

Swiss radar recorded the extended data from the aeroplane during its last thirty minutes of flight. These showed slow oscillations (periods between 45 and 80 seconds) and increasing amplitude in roll and the vertical speed. These oscillations seem to begin before the recording in mode S and before the pilot warned the Geneva controller of his difficulties. The periods and the amplitude of these variations suggest that they were not linked to turbulence and that the autopilot was not connected.



HB-FPZ's flight mode S extended parameters

2.7 Flight in Icing Conditions

In May 2010 an information circular[(2)] was issued by Transport Canada for air operators. The document aimed to help operators to define their training programmes and to *"raise pilots' awareness of the real dangers associated with flight into icing condition"*.

[(2)] This circular is not specific to the PC12

"Pilots may receive a warning of incipient roll upset if abnormal or sloppy aileron control forces are experienced after the auto-pilot is disconnected when operating in icing conditions."

The circular specifies, as a corrective measure:

- *"Disengage the auto-pilot and hand fly the aeroplane. The auto-pilot may mask important clues or may self-disconnect when control forces exceed limits, presenting the pilot with abrupt unusual attitudes and control forces."*

- *"When the autopilot is utilized in icing conditions, it can mask changes in performance due to the aerodynamic effects of icing that would otherwise be detected by the pilot if the aeroplane were being hand flown. It is highly recommended that pilots disengage the autopilot and hand fly the aircraft when operating in icing conditions. If this is not desirable for safety reasons, such as cockpit workload or single-pilot operations, pilots should monitor the autopilot closely. This can be accomplished by frequently disengaging the autopilot while holding the control wheel firmly. The pilot should then be able to feel any trim changes and be better able to assess the effect of any ice accumulation on the performance of the aeroplane. It is highly recommended that pilots disengage the autopilot and hand fly the aircraft when operating in icing conditions. If this is not desirable for safety reasons, such as cockpit workload or single-pilot operations, pilots should monitor the autopilot closely. This can be accomplished by frequently disengaging the autopilot while holding the control wheel firmly. The pilot should then be able to feel any trim changes and be better able to assess the effect of any ice accumulation on the performance of the aeroplane."*

3 - LESSONS LEARNED AND CONCLUSION

3.1 Pilot's Diagnosis and Loss of Control

Oscillations and unusual attitudes were present in the early stages of the event, before the pilot mentioned any issue to the air traffic controller concerning the autopilot.

This may indicate that the pilot had degraded situational awareness, which could have contributed to the loss of control. It was not possible to determine if the pilot's flying experience in IMC or icing conditions could have contributed to the loss of situational awareness. Further, the successive unusual attitudes adopted by the aeroplane were incompatible with action by the autopilot alone, even blocked in one position. The autopilot was thus likely disconnected during the oscillations. On the other hand, this situation and the recent case of the autopilot malfunctioning may have led to pilot to incorrectly diagnose a failure of the autopilot, which would explain the messages sent to the Geneva controller.

Available meteorological information indicated that some icing phenomena were likely in the area of the accident. It was not possible to determine the severity of the phenomenon, but it could have led to airframe icing. The initial attitude and speed oscillations shown by the enhanced mode S data is consistent with the contamination of the airframe and/or wing by icing. The incident that happened in Canada had similarities with those of this accident (meteorological conditions, and roll and altitude oscillations at altitude) but it cannot be established with certainty that the same situation occurred.

It is possible that the pilot was having difficulties in controlling his flight path due to icing accumulated on the wings and/or around the aileron control. This contamination may have led the pilot to make inappropriate control inputs, notable through over-correction of the aeroplane's attitude oscillations.

Two hypotheses may explain the aeroplane's loss of control when the airframe is contaminated by icing or the aileron control is made stiff by icing:

- the pilot having some difficulty in controlling his flight path, it is possible the aeroplane entered some cumulonimbus or strong turbulence, making the aeroplane uncontrollable;
- the pilot may have over-corrected the roll and altitude oscillations leading to an amplification of the phenomenon instead of compensating it.

A periodic check of the flight controls during the flight or not using the autopilot following its malfunction, as instructed in the flight manual, could have improved the pilot's situational awareness and helped to prevent the loss of control.

3.2 Onboard Flight Recorders on Light Aircraft

The carrying of onboard flight recorders on turbo-powered aeroplanes whose certified maximum takeoff weight is equal to or below 5,700 kg, and whose first individual Airworthiness Certificate is issued after 1st January 2016, is recommended by Annex 6 to the International Civil Aviation Convention on technical operations of aircraft. In addition, several Safety Recommendations have been issued by investigation authorities to extend the carrying of onboard flight recorders to other types of aircraft.

This subject is currently being studied by EASA through a Rulemaking Task (RMT.0271 Recorders for Small Aircraft) that was started in 2013 and is planned to be completed in 2016.

In addition, it should be noted that since aircraft serial number 1271, PC-12/47E's are equipped with protected combined CVFDR recorders.

As this Rulemaking Task is being studied by EASA at present, no Safety Recommendation has been issued at this stage.

3.3 Causes

The in-flight failure of the right wing was due to exceeding the aeroplane's structural limits (ultimate loads) during loss of control by the pilot.

In the absence of any flight recorders, the investigation was not able to determine the causes of this loss of control. It is possible that it may have been induced by a loss of situational awareness by the pilot at the controls of an aeroplane affected by an icing phenomenon. This phenomenon may have affected the aeroplane's wings or an area around the roll control.