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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report no. 2175 of the Swiss Accident Investigation Board SAIB

concerning the accident involving the
Piper PA-28-140 aircraft,
registration G-BBEF

on 14 October 2011

Petit-Beauregard, municipality of
Fontaines-sur-Grandson/VD

Cause

L'accident est dû à la collision de l'avion avec le sol, suite à une désorientation spatiale ayant provoqué une perte de contrôle en raison d'un manque de références visuelles extérieures.

General information on this report

This report contains the Swiss Accident Investigation Board's (SAIB) conclusions on the circumstances and causes of this aircraft accident.

In accordance with Art. 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 of the Convention on International Civil Aviation (ICAO) of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this report to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, this may give rise to erroneous interpretations.

The definitive version of this report is the original in the French language.

All times in this report, unless otherwise indicated, are stated in local time (LT). At the time of the accident, Central European Time (CET) applied as local time in Switzerland. The relation between LT, CET and coordinated universal time (UTC) is: $LT = CET = UTC + 2 \text{ hours}$.

Final report

Aircraft type	Piper PA-28-140	Registration	G-BBEF	
Operator	Robert Murgatroyd, Trading as Flybpl.com, 4 Pasture Drive, Garstang, Preston, PR3 1TH, UK			
Owner	Robert Murgatroyd, Trading as Flybpl.com, 4 Pasture Drive, Garstang, Preston, PR3 1TH, UK			
Pilot	British citizen, born in 1982			
Licence	PPL(A) (private pilot licence) according to ICAO, first issued by the United Kingdom Civil Aviation Authority CAA on 29 March 2010, valid till 28 March 2015. Language Proficiency, English. Radiotelephony (Flight Radiotelephony Operator's Licence), to be renewed not later than 4 October 2019.			
Class rating	Single engine piston – SEP (land), valid till 10 March 2012.			
Medical certificate	Class 2 (PPL) issued on 10 August 2009, valid till 10 August 2014.			
Flying hours	total	338:59 hours	during the last 90 days 23:54 hours	
	on the type involved	173:20 hours	during the last 90 days 23:54 hours	
Location	Petit-Beauregard, municipality of Fontaines-sur-Grandson/VD			
Coordinates	534 915 / 192 040 (Swiss Grid 1903) N 46° 52' 34" / E 006° 35' 05" (WGS 84)	Elevation	1410 m AMSL	
Date and time	14 October 2011, 10:57			
Type of flight	VFR day, private			
Phase of flight	Cruising			
Type of accident	Loss of control			
Injuries to persons				
Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	1	1	2	0
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	Not applicable
Total	1	1	2	0
Damage to aircraft	Destroyed			
Other damage	Tree damage and minor soil pollution			

1 Factual information

1.1 History of the flight

1.1.1 General

The pre-flight history and history of the flight were compiled on the basis of the statements of the persons called upon to testify for the purposes of the investigation and using the transcription of the radiotelephony communications between the pilot of the aircraft involved in the accident and the FIC flight information centre for Geneva lower airspace (Geneva Lower). The radar data enabled a plane 2-D reconstruction of the aircraft's trajectory.

1.1.2 Pre-flight history

The accident occurred during the flight back to England after a visit in Switzerland which the pilot had made between 5 and 14 October 2011.

He had already made the same journey from 15 to 21 June of the same year, on the occasion of which he had travelled from England to Neuchâtel aerodrome (LSGN) at the controls of the Piper PA-28-161, registration G-LFSJ. During this period, the pilot had flown 9 pleasure flights on this aircraft, with a total duration of 7:20 hours.

On 5 October 2011, accompanied by his wife, he took off from Full Sutton (EGNU) (GB) for the same journey at the controls of the Piper PA-28-140, registration G-BBEF, which he had leased in England. After a stopover in France in Amiens (LFAY), the aircraft landed at Neuchâtel aerodrome. The couple planned to remain until 10 October in the region, where they were staying with friends. During his stay in Switzerland the pilot made six pleasure flights on this aircraft with passengers, with a total duration of 7:55 hours.

On 10 October 2011, bad weather conditions forced the pilot to postpone his departure to a later date. His wife, who had professional obligations, returned to England on the same day, taking a scheduled flight.

On 12 October, the pilot flew with a passenger to Altenrhein (LSZR) onboard aircraft G-BBEF. There he made two local flights on the same day and returned to Neuchâtel the following day with the same passenger.

1.1.3 Accident flight

On 14 October 2011 at approximately 8:00, the pilot made his way to business premises in Neuchâtel, where he had an appointment with a friend who was to drive him to the aerodrome. Once there, he enquired electronically about the practicalities of submitting the flight plan and about the meteorological conditions relating to the journey planned for the morning.

The pilot and his driver called at his home to pick up another friend, with no flying experience, who had decided a few hours earlier to accompany the pilot on his flight back to England.

The three people arrived at Neuchâtel aerodrome at approximately 9:30 and went to the briefing office. The pilot submitted a flight plan, destination Amiens, in France, where he planned to make a refuelling stop. The indicated route simply included the town of Le Locle followed by a direct route to Amiens (DCT LFAY), with a flight time of 2:30 hours at a cruising speed of 100 kt.

Once the administrative formalities had been completed, the three friends made their way to the Piper PA-28-140 aircraft, registration G-BBEF, and the pilot filled

the tanks, adding 95 litres of fuel. He then carried out the pre-flight checks in accordance with the checklist provided for this purpose.

The person who had driven the pilot and his passenger took a photograph of them in front of the aircraft a few minutes before departure. The images show a sunny foreground whilst in the background a sky with stratocumulus can be discerned, largely overcast and with a base significantly lower than the peaks of the Jura (Fig. 1).

At approximately 10:35, the pilot sat at the controls of the Piper and his passenger took his place in the right hand seat. After starting the engine, the aircraft taxied to the threshold of runway 05 and then took off normally.

The taxiing on the ground towards the threshold of runway 05 and the take-off were filmed from the signal area. The video recording shows that the sky was clear and unobstructed on the Lake Neuchâtel side whereas on the Jura side it was overcast, as photographed earlier. In particular, it is possible to distinguish that the peaks in the direction of the Creux du Van were covered with fog. The final frames of the video show the aircraft climbing away along the runway centre line.

The aircraft then made a turn, probably to the right, in accordance with the departure procedures, and then flew along the northern shore of Lake Neuchâtel.

The first radar signal was recorded at 10:39:37, when the aircraft was passing the lakeside village of Bevaix. The transponder was transmitting code 7000 without altitude information, indicating that the pilot had not selected ALT mode. The limit of the radar coverage at this location lies between 3000 and 3500 ft AMSL.

Approximately ninety seconds later, a witness in the village of Saint-Aubin-Sauges saw the aircraft fly past; he distinguished its blue and white colours and it was flying from the north-east towards the south-west. He estimated its altitude as approximately 3000 ft AMSL. He described the meteorological conditions at that moment: *"Over St-Aubin-Sauges, fine and sunny with a few small scattered clouds. On the other hand, there were large clouds on the peaks (Creux du Van). Wind: a sustained 'Bise' wind."*

The radar data indicates that instead of heading for Le Locle as mentioned in the ATC flight plan, the pilot of the Piper flew along the shore of Lake Neuchâtel until he was north of Yverdon-les-Bains, where he made a 270° turn to the left and then assumed a north-westerly heading. At 10:53:27 he contacted the Geneva lower airspace flight information centre (FIC) and then requested a Basic Service. In his position report, he indicated that he was approximately 10 nautical miles west of Neuchâtel, at an altitude of 5000 ft and climbing to 5500 ft AMSL.

The FIC operator gave him the Geneva QNH altimeter setting and asked about his route. The pilot answered *"Heu direct to Lima, Lima Foxtrot Alpha Yankee, one zero two six... QNH Golf, Heu, Echo Foxtrot."* The operator acknowledged and assigned him transponder code 5101.

For the two minutes that followed, the operator was in radiotelephony communication with the pilots of two other aircraft. While the operator was replying to one of them, at 10:56:18 the pilot can be heard sending a message at the same time, with only the last portion perceptible: *"out of the clouds, of, Heu.."* which was spoken in a very agitated voice. At the same time, the pilot with whom the FIC operator was communicating read back his message.

The radar data shows that at this time the aircraft made a right turn followed by a tight left turn of approximately 290°; it was completed in approximately 20 seconds. The elevation of the overflown terrain is approximately 4800 ft AMSL.

The FIC operator, who was probably concerned by the overlap and mixing of the last radiotelephony messages, called G-BBEF back approximately 20 seconds later, at 10:56:43. The pilot replied that he had just re-entered the cloud and that he could not see anything: "*Echo Foxtrot, I'm just in clouds, cannot see anything.*"

A few seconds later, at 10:57:06, the blip of aircraft G-BBEF disappeared from the radar screen and the calls from the FIC operator remained unanswered.

The DETRESFA emergency plan was activated at 11:05:17.

At approximately 16:30, the wreckage of the Piper PA-28-140 was found at the edge of a wood on a ridge of the Jura, at the location known as "Petit Beauregard". The aircraft was destroyed and its two occupants were fatally injured.



Fig. 1: 2-D representation of the aircraft's route.



Fig. 2: Final turns of the aircraft. The section of the route in red is an extrapolation.

1.2 Meteorological conditions

1.2.1 General

The information presented in sections 1.2.2 to 1.2.8 is extracted from the meteorological record which MeteoSwiss drew up at the request of the SAIB for the purposes of the inquiry. The original text is in German; the only information selected concerns the general situation, the situation which prevailed in the region of Fontaines-sur-Grandson and the meteorological factors which may have had an influence on the history of the incident.

Section 1.2.9 summarises the significant points of the meteorological observations made by the witnesses called on to make statements as part of the investigation.

1.2.2 General meteorological situation

An active ridge of high pressure extended from the Iberian Peninsula to the north of Norway. It strengthened the high pressure zone on the ground centred over Denmark. Switzerland was to its south, in an airflow originating from the east-north-east and active up to high altitudes.

1.2.3 Meteorological situation in the Fontaines-sur-Grandson region

Early in the morning, the west of the Swiss Plateau was largely covered by dense fog at altitude. From 9:00, it partially dissipated along a stretch approximately 30 km wide extending from Bern to Neuchâtel. From 10 to 11:00, it continued to clear over Lake Neuchâtel towards the south-west. At midday, only a few high banks of fog persisted between Fribourg and the Vaudois Jura. In the west, the foot of the southern slopes of the Jura had largely cleared.

The upper limit of the high-altitude fog was related to a significant temperature inversion beginning at an altitude of 5000 ft. Its lower limit was distinctly heterogeneous. At Payerne aerodrome, the latter extended to an altitude of approximately 3000 ft at 08:50 and 5500 ft at 10:50.

A moderate 'Bise' wind was blowing.

1.2.4 Meteorological situation in the region and at the time of the accident

At 11:00, the high-altitude fog cleared quickly in the Grandson region. Along the northern shore of Lake Neuchâtel, banks of fog alternated with strips of thin cloud. Due to the Bise's elevation effect, the cloud base was lower close to the slopes of the Jura than over the Swiss Plateau.

The following indications concerning the local meteorological conditions at the time of the accident are based on a spatial and chronological interpolation of the observations made at several weather stations located in the environs.

<i>Weather/cloud</i>	<i>5-7/8 stratus and fog on slopes</i>
<i>Visibility</i>	<i>Variable, probably between 5 and 8 km, lower below the fog base</i>
<i>Wind</i>	<i>040° / 15 kt</i>
<i>Temperature / dew point</i>	<i>9 / 5° C</i>
<i>Atmospheric pressure</i>	<i>EDNY 1029 hPa, LSZH 1028 hPa, LSMP 1027 hPa, LSGG 1026 hPa</i>

1.2.5 Astronomical information

Position of the sun *Azimuth: 141°*
Fontaines-sur-Grandson *Elevation: 27°*
Natural lighting conditions *Daytime, late morning*

1.2.6 Payerne aerodrome meteorological information

Payerne is the nearest airfield to the scene of the accident for which METAR observations are made. Those at 07:50, 08:50 and 09:50 UTC were as follows:

METAR LSMP 140750Z 05008KT 020V080 6000 BKN015 OVC040 09/06 Q1027
RMK GRN=

METAR LSMP 140850Z 06010KT 020V080 6000 BCFG SCT015 BKN040 10/05
Q1027 RMK GRN=

METAR LSMP 140950Z 06008KT 020V090 8000 FEW020 11/06 Q1026 RMK
BLU=

1.2.7 Forecasts

For the day of the accident, the only aerodrome forecast (terminal aerodrome forecast - TAF) available for Payerne aerodrome was produced for the period from 12:00 to 21:00 UTC.

1.2.8 Hazardous meteorological report

No hazardous meteorological report was active in the region of the accident.

1.2.9 Meteorological conditions observed by witnesses

The photographs and the video sequence recorded at the aerodrome prior to departure by the person who drove the two occupants of the Piper indicate different aspects of the cloud cover in the area. Several statements were taken concerning the weather conditions prevailing along the route of aircraft G-BBEF. The situation in flight was described by a private pilot who was making a VFR flight from Lausanne La Blécherette (LSGL) airport to Neuchâtel, where he landed approximately 1 hour before the departure of the Piper involved in the accident.



Fig. 3: Meteorological situation at the time of take-off , view towards southwest.

- In-flight meteorological observations:
"After the take-off from runway 36 at LSGL, I noted that east of the Lausanne-Payerne axis the large cloud mass, BKN to OVC, extended almost to the ground, whereas its base in the direction of the Jura was at approximately 4500 ft with a SCT to BKN coverage. I estimated the top as between 5000 ft and 5500 ft. My cruising altitude as far as Yverdon was 4000 ft.
At Yverdon I was forced to descend to 3000 ft, the ceiling was down to between 3000 ft and 3500 ft. The peaks of the Jura were not visible. The cloud clung to the slopes right down to the ground.
My route followed the shore of the lake as far as my destination, where the cloud layer was less pronounced (SCT).
Throughout the flight, visibility was over 10 km."
- Meteorological observations at the time G-BBEF passed Saint-Aubin-Sauge:
"Weather: over Saint-Aubin-Sauges, fine and sunny, with a few scattered clouds. On the other hand, there was significant cloud on the peaks (Creux du Van).
Wind: a sustained 'Bise' wind."
- Meteorological observations at the time of the accident, 1 km west of the scene of the accident:
"I was in sunshine but the area of the accident was in fog. I estimate that the lower limit of the fog was at approx. 1350 m AMSL. I also saw the upper limit of the layer which I estimated to be at approx. 1500 m AMSL."
"Yes, a fairly strong but steady 'Bise' wind situation. The temperature was probably between 7 and 10 °C."
"During this search approximately 20 min after the sound was heard, I was partially in fog "

1.3 Aircraft information

Registration	G-BBEF
Aircraft type	Piper PA-28-140
Characteristics	Single-engined four-seater, low wings, metal construction with fixed landing gear in nose wheel configuration.
Manufacturer	Piper Aircraft Corporation, USA
Year of manufacture	1973
Serial no.	28-7325527
Registration certificate	Issued by the CAA, on 16 October 2009
Airworthiness review certificate	Airworthiness Review Certificate ARC, issued on 31 August 2010 at 14,448:00 hours TSN ¹ , valid until 30 August 2011
Area of use	VFR (visual flight rules)
Emergency beacon	Not fitted

¹ TSN – time since new

Engine	Manufacturer: Lycoming Engines, Williamsport, USA. Characteristics: boxer type 4 cylinder engine, air cooled, maximum power 150 HP (111.8 kW). Type and serial no.: O-320-E3D, s/n L-30957-27A.
Propeller	Manufacturer: Sensenich Propeller Manufacturing Co. Inc. Characteristics: Two-blade, metal, fixed pitch. Type and serial no.: 74DM6-0-58, s/n 57359.
Total operating hours	Airframe: 14614:42 hours TSN Engine: 714:52 hours TSO ² Propeller: 294:42 hours TSO
Equipment	1 GPS Colour Toppo Sky map III, 1 COM/NAV, 1 transponder, 1 ADF, 1 artificial horizon, 1 directional gyro, 1 turn and bank indicator.
Masses	Empty mass 630 kg (1389 lb) Max. take-off mass 975 kg (2150 lb)
Mass and centre of gravity	At the time of the accident, the mass and centre of gravity were within the prescribed limits.
Fuel	AVGAS 100LL
Capacity of the tanks	Total capacity of the tanks is 50 US gal (189.25 l). The quantity of non-useable fuel is 2 US gal (7.5 l).
Quantity of fuel onboard	After the check of the quantities of fuel added and calculation of average consumption for the flights made between 11 and 14 October 2010, it was estimated that the fuel remaining in the tanks at the time of the accident was 150 to 175 l.

1.4 Wreckage and impact information

1.4.1 Site of the accident

The accident occurred on the edge of a wood on a ridge of the Jura, 250 m from the location known as "Petit Beauregard" above the municipality of Fontaines-sur-Grandson/VD, approximately 3 km south of the village of Fleurier/NE. This wild, undulating area is made up of forest areas interspersed with pasture and a scattering of conifers.

The wreckage was at an elevation of 1410 m AMSL, on the edge of a wood and on a slope of approximately 30%.

1.4.2 Impact information

The site of the accident is characterised by a debris field extending approximately 60 metres, orientated to the north-west, along which the Piper was progressively destroyed by a succession of collisions with conifers and the terrain. The initial impact was with a fir tree; the broken branches and the marks on the trunk 6-8 metres from the ground indicate that the aircraft impacted in a nose dive, inclined

² TSO – *time since overhaul*

to the left at almost 45°. The left wing broke off and the extremities remained attached to the tree.

The main impact took place 15 metres further along, at the foot of a second fir tree. The right wing broke off from the fuselage there; part of it remained at this location. The fuel tank ruptured and the aircraft caught fire immediately. As a result of the force of the impact, the rest of the aircraft disintegrated and its debris was scattered over more than 20 metres in the direction of travel.

The seats and their occupants were ejected and thrown forward of the rear part of the fuselage, 35 metres from the initial impact.

The engine and the front section of the cabin constituted the final impact of the accident and came to a halt 58 metres from the initial impact.

1.4.3 Wreckage information

The numerous traces from the aircraft and the pronounced scattering of debris of all sizes bear witness to the violence of the collision with the trees and the ground. After the tanks ruptured, part of the wing and several components of the aircraft were consumed and destroyed by fire. It was not possible to collect a fuel sample.

The fuselage broke into several sections, the largest of which was the tail. The three wheels of the landing gear were propelled in different directions beyond the main impact point.

Some flight instruments were separated from the instrument panel; its battery switches, alternator and landing light were found engaged. Those for the anti-collision lights and Pitot heating were in the "OFF" position. The state of destruction of the dashboard and the front of the cabin made it impossible to determine the position of the throttle, mixture and carburettor heater controls. It was not possible to determine the positions of the elevator trim and the wing flaps.

The power-unit was badly damaged. The propeller, the left magneto, the alternator and the carburettor were separated from the engine during the impacts. The crankshaft flange suffered major deformation. The six propeller fixing bolts sheared and the propeller was found 13 metres to the left of the engine. Its two blades were bent and twisted rearwards, indicating that the engine was delivering power at the time of contact with the terrain.

A witness 1 km west of the scene of the accident reported the following facts:

"... I heard the noise of an engine revving, i.e. a very high speed for a few seconds (2-3) followed by a loud impact noise, corresponding to the cracking caused by branches breaking off."



Fig. 4: Rear section of the fuselage.

1.5 Medical and pathological information

The pilot and his passenger underwent an autopsy. The reports did not reveal any pre-existing pathology which might have played a part in the fatal sequence of events.

The toxicological analyses of the two occupants of the aircraft did not reveal the presence of alcohol, drugs or medication.

The death of the two occupants was caused by a severe multiple trauma resulting in immediate death.

1.6 Search and survival aspects

The aircraft was not equipped with an emergency beacon. The police services activated detection of the pilot's mobile telephone and quickly located the device in the Chasseron/VD region.

A 406 MHz PLB (Personal Locator Beacon) was found not far from the fuselage debris. Its antenna was extended but it was not activated. The tests which were carried out revealed that the device was functional.

Given the force of the impact with the trees and the terrain, the pilot and his passenger did not have any chance of survival.

The front seats of the aircraft were equipped with three-point seat belts. The pilot's lap belt was found "fastened"; the passenger's was open. The shoulder belt was not used by either occupant.

The use of the safety belts could not prevent the death of the two occupants.

1.7 Fire

Following the extremely violent impacts suffered by the aircraft during the accident, the fuel tanks ruptured. The locations and parts sprayed by gasoline immediately caught fire. Parts of the wing and of the cabin, such as seats, were completely consumed by fire.

1.8 Tests and research

1.8.1 Examination of the airframe

Despite the serious damage, it was possible to carry out a visual examination of the airframe components. The inspection produced no evidence of any prior defect.

The documentation as well as the documents relating to the technical maintenance of the aircraft were consulted and verified. It was noted that the statements concerning the 150-hour check were not clear. Some show an annual check initially certificated and then struck out, replaced by a 150-hour check: this is the case for the annual check due on 20 August 2011 at the latest. Moreover, the Airworthiness Review Certificate (ARC), issued on 31 August 2010, expired on 30 August 2011. The accident occurred on 14 October, i.e. 44 days after the expiry date. The aircraft logbooks reveal that it made 28 flights for a total of 21:27 hours from 30 August 2011. Finally, in the engine booklet there is an EASA Form 1 dated 25 August 2009. It stipulates an engine overhaul by the Dukeries Aviation company. No certification or entry other than the EASA Form 1 could be found in the engine logbook. The hours of operation since the overhaul (TSO) were not updated. There were no annotations in the aircraft's logbook.

1.8.2 Inspection of the engine

Some of the engine fittings were badly damaged on impact with the ground.

The front flange the crankshaft was deformed, preventing any attempt at engine rotation. Significant traces of rust were found on the front section; others were detected on some cylinders as well as on the engine mounting.

Of the eight spark plugs in the engine, four were damaged during the accident and the lower plug of cylinder no. 2 was torn out. It was possible to test the remaining three which were found to be in working condition. All the spark plugs were badly rusted on the outside and their electrodes exhibited extensive wear. The presence of lead was confirmed inside some of them.

On impact with the ground, the upper section of the carburettor broke off and took with it the fuel filter, the butterfly valve and its control. A bench test could not be carried out. The float was of the metal type. Its lateral play was measured and found to be outside the tolerances stipulated by the manufacturer. No friction point was found in the bowl.

The oil remaining in the crankcase was black in appearance. An inspection of the latter's oil filter revealed the significant presence of chips, essentially of aluminium and round in shape, 2 to 3 mm in diameter. Their origin could not be determined. A large quantity of metallic particles, mainly aluminium, was also found in the filter section of the oil filter cartridge.

It was possible to test both magnetos despite the partial destruction of the left magneto. No malfunction was detected. The key to their switch was broken off in the accident; examination revealed that it was in the "Both" position.

1.8.3 Examination of the onboard instruments

The results of the inspection are the following:

- Airspeed indicator (Fig. 5): impacts of the indicator needle were detected up to a value of 188 mph (302 km/h).

The aircraft flight manual indicates the following speed limits: green arc (normal operation) between 64 mph (103 km/h) and 140 mph (225 km/h), amber arc (caution zone) from 140 to 171 mph, never exceed speed (VNE - red line) at 171 mph (275 km/h).

- Rpm indicator (Fig. 6): the indicator needle impacts were detected between 2800 and 3200 rpm, with the needle jammed at 3100 rpm.

The flight manual indicates a normal engine operating range from 500 to 2700 rpm (red line).

- Vertical speed (Fig. 7): needle impact indicators were detected in the DOWN sector at values between 1900 and 2000 ft/min.

The limit values indicated on the instrument are 2000 ft/min UP and DOWN.



Fig. 5: Airspeed Indicator. The yellow arrow indicates 173 mph, the green arrow 170 mph and the red arrow indicates 188 mph, the maximum airspeed reached.



Fig. 6: Rpm Indicator. Needle impacts were detected from 2800 rpm, yellow arrow. The red arrow indicates 3200 rpm, the maximum rpm reached.



Fig. 7: Vertical Speed. The red triangle indicates 1900 to 2000 ft/min DOWN, the sector where impacts were registered on the instrument.

1.9 Additional information

1.9.1 Spatial disorientation

Spatial disorientation is the temporary inability of a pilot to correctly determine his actual movement, i.e. that of the aircraft, in relation to the ground. It depends on physiological, psychological and environmental factors.

In the case of visual flight, i.e. based exclusively on external visual references, the environmental factors are those that reduce the amount of information to which the pilot normally has access in VMC flight conditions (visual meteorological conditions). Entering cloud makes it impossible to distinguish the horizon and a pilot without instrument flight experience will quickly come to rely only on his impressions. Balance and orientation are now no longer controlled by vision and are affected by the malfunction of the vestibule, the inner ear organ, which is poorly adapted to aeronautical stresses. The result is so-called vestibular illusions, which are the origin of spatial disorientation³.

³ Note: A detailed explanation of this phenomenon is beyond the scope of the investigation, but interested readers can refer to the thesis entitled "La désorientation spatiale en aéronautique" (Spatial disorientation in aeronautics) by Franck Mars.

The psychological factors are those which impact on the conscious part of the brain by providing it with more information than it can process. Visual navigation in degraded visibility conditions can become so absorbing that the pilot becomes overwhelmed by tasks and no longer has the resources to extricate himself from a dangerous situation.

The physiological factors are those which limit the pilot's effectiveness. Fatigue and medications can reduce these limits. They affect the pilot's concentration and reduce the number of tasks he is able to process.

1.10 Useful or effective investigation techniques

1.10.1 Use of radar data

Since the aircraft's transponder was in mode A, no altitude information is available.

By processing the file containing the raw data from the Lägern and Grand-Ballon radar stations recorded between 08:39:37 and 08:57:06 UTC, it was possible to establish the 2-D representation of the trajectory.

2-D representation of the trajectory

The 2-D representation of the resulting trajectory shows that at the time of the last radar contacts, identified between 08:56:18 and 08:56:46 UTC, the aircraft made a right turn followed by a tight left turn of approximately 290°, completed within approximately 20 seconds. By connecting the last point of radar contact with the aircraft's point of impact with the ground, it is evident that this last part of the route is a continuation of the trajectory.

Ground speeds

The ground speeds reconstructed by the Grand-Ballon radar tracker have an accuracy of 5-8 kt, but with a somewhat greater spread in the last seconds of recorded flight.

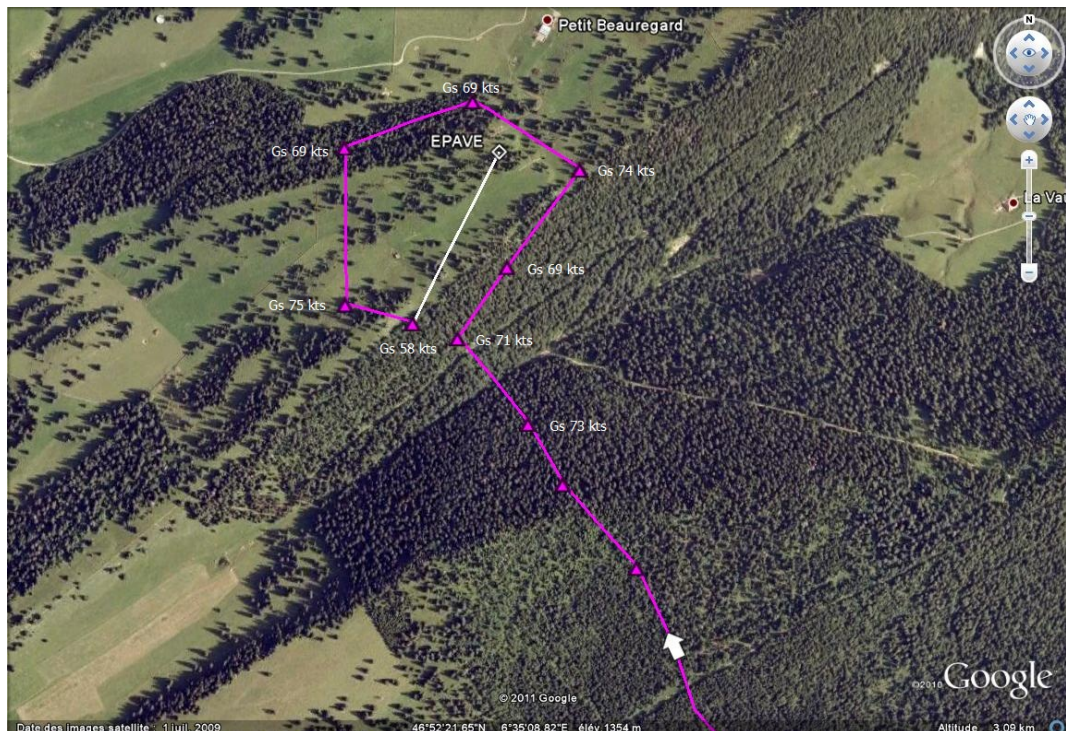


Fig. 8: Ground speeds reconstructed by the Grand-Ballon tracker

Estimate of the bank angle in relation to the horizontal plane for the last 20 seconds of the radar recording

The last 20 seconds recorded indicate that the aircraft was making a turn with a radius of approximately 140 m, at a bank angle of 43°, corresponding to a load factor of 1.37 g.

Comments

- The turn was carried out at a relatively constant speed for as long as the aircraft was out of the cloud. When the pilot reported that he could no longer see anything, the average ground speed had a decreasing trend.
- The 2-D representation of the trajectory indicates that the pilot flew into cloud when he was in a tight turn.
- The loss of radar contact indicates that the aircraft passed below radar coverage and that it was therefore descending.

2 Analysis

2.1 Technical aspects

The investigation revealed no indication of defects in the structure or the power-unit which may have caused the accident. The testimony of the person who heard the crash also largely confirms this.

2.2 Operational aspects and human factors

2.2.1 Influence of the meteorological conditions on the aircraft's route

Little evidence could be found concerning the meteorological information obtained by the pilot for the preparation of his flight, unless this was obtained electronically. However, these sources provide no details of local situations and in particular those prevailing in the region of the accident. A VFR pilot can rely in this regard only on local weather observations which he has to make himself.

Since at the time of the preparation of the aircraft the sky was clear over Lake Neuchâtel, it is possible that the pilot did not realise that the cloud to the north might make it difficult to pass the peaks of the Jura. The fact that he did not fly regularly in this region certainly played a part in reducing his perception of the local weather phenomena.

The radar plot of the pilot's route suggests his tactic was to gain altitude while flying over the north shore of the lake on a south-westerly heading, because the weather was fine there. He could therefore seek a possible opening on his right which would enable him to turn towards his destination.

When the pilot reached the end of the lake, he turned back while still remaining on the side of the clear skies and then assumed a north-north-westerly heading which exactly corresponds to the direct GPS route to Amiens. Moreover, it was this route and an altitude of 5000 ft which he reported on making contact with the FIC. It is not known if the pilot considered that at this time he had sufficient altitude to clear the peaks of the Jura, if he judged that he was higher than the cloud barrier covering them or if he had located a passable route.

During the second radiotelephony contact with the FIC, the pilot manifested considerable distress, perceptible in the tone of his voice and the fact that he overlapped with another message. At the same time, he rapidly changed direction to the right. A few seconds later he turned left by 290°, tightening his turn. Manoeuvres and directional changes of this magnitude are certainly attributable to an attempt to avoid an obstacle. The altitude reported by the pilot, his last ATC message, indicating that he could no longer see anything, and the stratocumulus on the peaks of the Jura confirm that this obstacle consisted of cloud.

2.2.2 Spatial disorientation

The testimonies concerning the pilot's health and state of fatigue, as well as the results of his autopsy, attest that his physiological condition did not *a priori* have any effect on the spatial disorientation. Psychological and environmental factors are probably the cause.

At the psychological level, the awareness that entry into the cloud mass was inevitable caused intense and growing stress in the pilot. One sign of this is the radiotelephony message he transmitted, to the detriment of ongoing communications. The perceptible distress in the report a few seconds later that he could no longer see anything is also indicative of this. The very exacting search for a solution enabling him to stay out of the cloud seriously taxed the conscious part of his brain, considerably limiting his discernment and responsiveness.

Environmental factors reduced to zero the amount of information which a pilot can normally access in visual flight conditions. The only points of reference available from then on were the onboard VFR instruments, which become impossible to interpret in a state of psychological overload. The pilot then relied only on his own sensory impressions.

2.2.3 Nose dive

The following factors marked the last seconds of flight:

- the manoeuvres deduced from the radar recordings are characterised by a tight turn at a high bank angle;
- the last radar contact position is close to the site of the wreckage;
- the axis of the accident debris field is orientated to the north-west;
- the initial impact with the terrain indicates that the aircraft struck it in a vertical dive, at a bank angle to the left of almost 45°;
- the values registered on the flight instruments at the moment of the collision considerably exceed the prescribed limits.

These factors are characteristic of a spiral nose dive.

The last seconds of flight probably unfolded as follows: the pilot flew into cloud; he tried to avoid it by making a tight left turn. Deprived of any external visual reference, the considerable load factor encouraged him to release pressure on the elevator controls and the aircraft assumed a nose dive attitude. The spiral dive began. The pilot ceased to perceive that he was turning but observed a significant loss of altitude on the altimeter. To combat this, he was tempted to pull on the stick and increase engine power. The airspeed and the turn radius increased until impact with the ground occurred.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- At the time of the accident, the mass and centre of gravity were within the limits prescribed by the manufacturer of the aircraft.
- The investigation did not reveal any indication of defects in the structure or the power-unit which may have caused the accident.
- Airspeed indicator needle impacts were registered up to 188 mph (302 km/h).
- Impacts of the rpm counter needle were registered up to 3200 rpm with the needle jammed at 3100 rpm.
- Vertical speed indicator needle impacts were detected in the DOWN sector at values between 1900 and 2000 ft/min.
- The aircraft was not equipped with an emergency beacon.

3.1.2 Human aspects

- The documents provided indicate that the pilot was in possession of an adequate licence.
- There is no indication that his state of health was affected at the time of the incident.

3.1.3 History of the flight

- The route indicated in the flight plan submitted by the pilot simply included the town of Le Locle, followed by a direct route to Amiens (DCT LFAY).
- In his ATC position report, the pilot reported that he was approximately 10 nautical miles west of Neuchâtel, at an altitude of 5000 ft and climbing to 5500 ft.
- At 10:56:18, the pilot sent a message which overlapped with a radiotelephony communication in progress. Only the end "*out of the clouds, of, heu*", spoken in a very agitated voice, is perceptible.
- The radar data indicates that at this time the aircraft was making a right turn followed by a tight left turn of approximately 290°, which was completed in approximately 20 seconds. The altitude of the overflown terrain is approximately 4800 ft.
- At 10:56:43, the pilot reported to the FIC operator, that he had just flown back into cloud and could no longer see anything.
- At 10:57:06, the radar blip of aircraft G-BBEF disappeared from the screen and FIC operator's calls to it remained unanswered.
- The DETRESFA emergency plan was activated at 11:05:17.
- At approximately 16:30, the wreckage of the Piper PA-28-140, registration G-BBEF, was found at the edge of a wood on a ridge of the Jura, at the location known as "Petit Beauregard".

3.1.4 Environmental aspects

Photographs taken at Neuchâtel aerodrome from the signal area, just before and during the departure of aircraft G-BBEF, show that the sky was clear and cloudless on the Lake Neuchâtel side. Over the Jura, the sky was mostly cloudy, with much stratocumulus, the base of which was significantly lower than the peaks.

3.2 Cause

The accident is due to the collision of the aircraft with the ground, following spatial disorientation causing a loss of control due to a lack of external visual references.

Payerne, 18 April 2013

Swiss Accident Investigation Board

This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).

Berne, 16 May 2013