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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2143 by the Swiss Accident Investigation Board SAIB

concerning the accident involving the Piper PA-28-161 aircraft, registration HB-PPG

on 24 March 2009

Bellechasse (LSTB) airfield, Bas-Vully municipality/FR

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Ursachen

Der Unfall ist auf eine Kollision mit Hindernissen nach einer Notlandung wegen Leistungsabfall des Triebwerks zurückzuführen. Der Leistungsabfall wurde mit grosser Wahrscheinlichkeit durch eine Vergaservereisung ausgelöst.

Zum Leistungsabfall beigetragen hat der mangelhafte technische Zustand der Vergaservorwärmung.

General information on this report

This report contains the Swiss Accident Investigation Board's (SAIB) conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Art 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation 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 investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

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

All times in this report, unless otherwise indicated, are in local time for Switzerland, which at the time of the accident/serious incident, corresponded to Central European Time (CET). The relation between LT, CET and UTC (universal time coordinated) is:
LT = CET = UTC + 1 hour. (or: UTC = LT – 1 = CET – 1)

Final Report

Aircraft type	Piper PA-28-161 Warrior III	HB-PPG
Operator	Segel- und Motorfluggruppe Grenchen	
Owner	Segel- und Motorfluggruppe Grenchen	

Flight instructor	Swiss citizen, born 1947
Licence	Airline transport pilot licence aeroplane – ATPL(A) according to joint aviation requirements (JAR), first issued by the Federal Office of Civil Aviation (FOCA) on 24 March 1988.
Essential ratings	Flight instructor airplanes - FI(A), valid till 17 October 2011. Type rating for single engine piston – SEP (land), valid till 13 June 2010.
Medical certificate	Class 1, restriction: VNL shall have available corrective lenses. Start of validity: 27 October 2008. End of validity: 17 May 2009.

Flying hours	**Total**	16,962 hours	**during the last 90 days**	69 hours
	on the accident type	approx. 1000 hours	**during the last 90 days**	64 hours

Trainee pilot	German citizen, born 1978
Licence	Trainee (A) licence, valid till 3 November 2010
Ratings	None
Medical certificate	Class 1 without restrictions. Start of validity: 3 November 2008. End of validity: 3 November 2009.

Flying hours	**Total**	22:09 hours	**during the last 90 days**	22:09 hours
	on the accident type	22:09 hours	**during the last 90 days**	22:09 hours

Location	Bellechasse (LSTB) airfield		
Coordinates	--	**Elevation**	--
Date and time	24 March 2009, 14:35		
Type of operation	VFR training flight		
Flight phase	Climb		

Accident type	Collision with obstacles after an emergency landing due to loss of power

Injuries to persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	---	---	---	---
Serious	---	---	---	---
Minor	---	---	---	---
None	2	---	2	Not applicable
Total	2	---	2	---

Damage to aircraft	Damage to wings and spinner
Other damage	Pasture fence damaged, minor damage to farmland

1 Factual information

1.1 History of the flight

1.1.1 General

For the following description of the context and history of the flight the statements of the flight instructor, the trainee, the flying school manager and witnesses were used. In addition, a brief radar recording was available. It was possible to reconstruct the aircraft's landing roll after the emergency landing on the basis of the tracks in the fields and pasture.

1.1.2 Flight preparations

The flight took place within the framework of the Swiss Aviation Training (SAT) pilot's course. For this purpose, the SAT used aircraft of the flying school Grenchen.

The flight took place as part of training phase 2. This phase comprises landings in abnormal situations and emergency landing exercises. The flight programme included landing training in Grenchen and simulated emergency landings, so called power idle approaches, outside the airport area.

1.1.3 History of the flight

The pilots took off from Grenchen on 24 March 2009 at 13:48 on the training flight. It was a cold day with low clouds. Before the first flight of the day they carried out an engine runup (ground check) in accordance with the SAT checklist. The crew noted a drop in engine speed of 30-50 rpm during the carburettor heater function check.

After take-off, the pilots first carried out four aerodrome circuits with touch and go exercises on runway 25 and then left the Grenchen control zone via the crosswind leg in the direction of Biel.

In the vicinity of Biel a first simulated emergency landing was carried out. At approximately 3000 ft AMSL, the initial altitude was somewhat low for the exercise because of cloud. The flight instructor described this as follows: *"In the cruise we had to deviate occasionally to avoid clouds".*

The exercise was conducted in accordance with the SAT training documentation. It was initiated by reducing to idle power and simultaneously switching on the carburettor heater. The flaps were fully extended to 40 degrees; there was a relatively strong headwind. In the go-around, full power was set and the carburettor heater was switched off again. The engine accelerated to full power without any problems ("*without coughing*"); no vibration was perceptible. The fuel pump remained on until the cruise check.

Between Biel and Bellechasse a second simulated emergency landing was carried out in the Täuffelen area. Then the crew entered the Bellechasse area, where they initiated the simulated emergency landing over Bellechasse airfield.

The instructor described this as follows: *"Normal approach on runway 26 in Bellechasse, landing would have been possible. Go around without any problems, full power set, then carb heat switched off".*

20 to 30 seconds during the climb after the go-around, there was a sudden power loss at approximately 400 ft AGL. *"Sudden rumbling or rattling, reminded of mechanical noise, with vibrations."* The manipulations on the power lever had no effect; the engine was no longer providing power. In accordance with standard SAT procedures, the flight instructor assumed control of the aircraft. Given the inappropriate emergency landing surface directly ahead, with woods and high-voltage

power lines, he decided to return to Bellechasse airfield in a tight left turn. This turn was flown at a bank angle in excess of 45 degrees and at sufficient speed. The engine was idling, possibly only because of the airflow (windmilling). The instructor was not able to monitor any other engine parameters; he was flying instinctively. The trainee supported him with reports of obstacles.

The aircraft was not able to reach the grass runway and touched down just short of the threshold of runway 08. After touchdown at approximately 14:35, the aircraft collided with a pasture fence in farmland and came to a standstill after approximately 400 m, in a damaged state. The instructor saw the fence only at the last moment; due to the rapid change of events he landed without flaps.

The propeller was turning until touchdown and subsequently stopped, without any intervention by the pilots.

The final position of the aircraft was in a field approximately 200 m north of the airfield.

The crew was able to exit the aircraft uninjured.

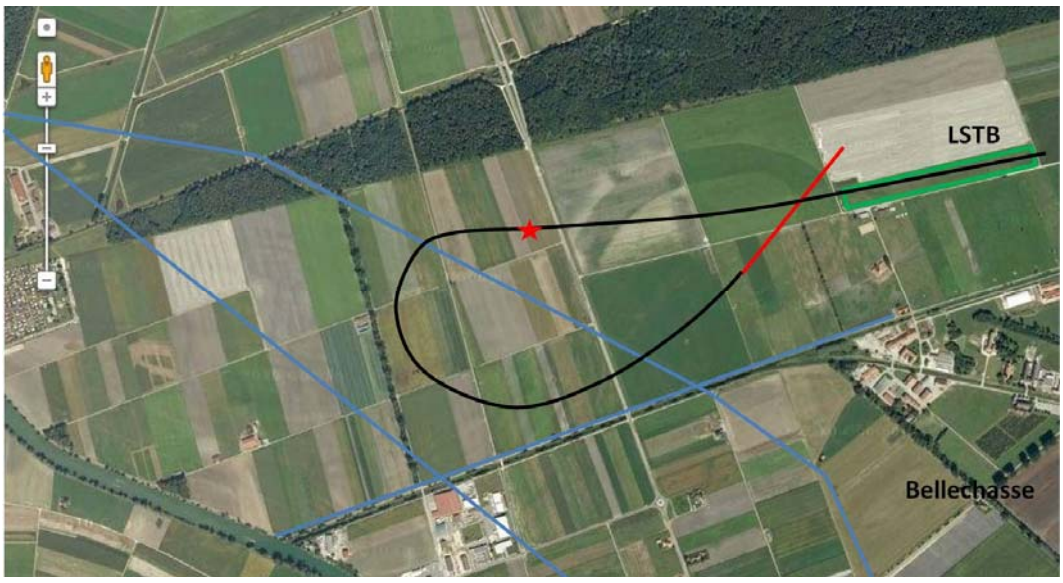

Figure 1: Situation overview, emergency landing of aircraft HB-PPG
Black: Flight path according to instructor's statement
★ Approximate location of power loss
Red: Landing roll according to traces
Blue: Power lines (high and medium voltage)

Figure 2: Final position of the damaged aircraft HB-PPG

1.2 Meteorological information

1.2.1 General meteorological situation

In the wake of a depression centered over Belarus, strong upper level winds steer humid polar air towards the Alps (c.f. Annex 1)

Clouds, visibility, weather
In the Alps (...) In other areas 4-7/8, cloud base 3500-4500 ft/AMSL.

Isolated showers of rain or snow were also forecast.

Wind and temperature forecast North of the Alps:

Forecast of wind and temperature north of the Alps:

Altitude	**Degree/kt**	**Temperature**
Ground	WNW 8-13 kt	
5000 ft	320 / 025	-05 °C
10000 ft	330 / 025	-15 °C
18000 ft	360 / 050	-29 °C
2800 ft	Freezing level	

1.2.2 Meteorological aviation routine weather report (METAR)

The following METAR for the nearby aerodromes of Payerne and Grenchen were valid at the time of the accident:

LSMP 241350Z 36006KT 300V060 9999 FEW010 SCT035 06/M03 Q1012 RMK WHT=

In plain language this means

On 24 March 2009 the following weather conditions were observed at Payerne aerodrome at the issue time of the aerodrome weather report of 13:50 UTC, i.e. approx. 15 minutes after the accident:

Wind	Variable from 300° to 060°
Meteorological visibility	10 km or more
Cloud	1-2/8 at 1000 ft AAL 3-4/8 at 3500 ft AAL
Temperature	6 °C
Dewpoint	-3 °C
Atmospheric pressure	1012 hPa, pressure reduced to sea level, according to ICAO standard atmosphere

LSZG 241350Z 29012KT 9999 VCSH FEW030 BKN063 05/M03 Q1012 NOSIG=

In plain language this means:

On 24 March 2009 the following weather conditions were observed at Grenchen aerodrome at the issue time of the aerodrome weather report of 13:50 UTC, i.e. approx. 15 minutes after the accident:

Wind	from 290° at 12 kt
Meteorological visibility	10 km or more

Precipitation	Showers in the vicinity
Cloud	1-2/8 at 3000 ft AAL 5-7/8 at 6300 ft AAL
Temperature	5 °C
Dewpoint	-3 °C
Atmospheric pressure	1012 hPa, pressure reduced to sea level according to ICAO standard atmosphere

1.2.3 Weather at the time and location of the accident

In accordance with these METARs and data from weather observation stations in the vicinity, it can be assumed that at the time of the accident the temperature on the ground was approximately 5° C, with a dew point of -3° C.

1.2.4 Conditions for carburettor icing

Under the given conditions, carburettor icing was possible. Figure 3 shows an analysis based on the conditions prevailing on the day of the accident. In the wake of the cold front which passed before noon the temperature and dew point have changed approximately 1, respectively 0.2 °C per 100 m altitude. This is due to the well mixed convective boundary layer below the local cloud base. Based on temperature/dewpoint of 5/-3 °C at surface the respective values reach 0/-4 °C at 3000 ft AMSL (tolerance 1 °C). The radiosonde observation of Payerne (according to Annex 1) indicates a dewpoint of -7 °C at 3000 ft/AMSL. The difference can be explained by a higher moisture content of the air in the vicinity of the Lakes of Bienne, Morat and Neuchatel compared to the hilly surroundings of the aerological station of Payerne. The two points on the graph are therefore set at 5/-3 and 0/-7 (temperature/dewpoint in °C), respectively.

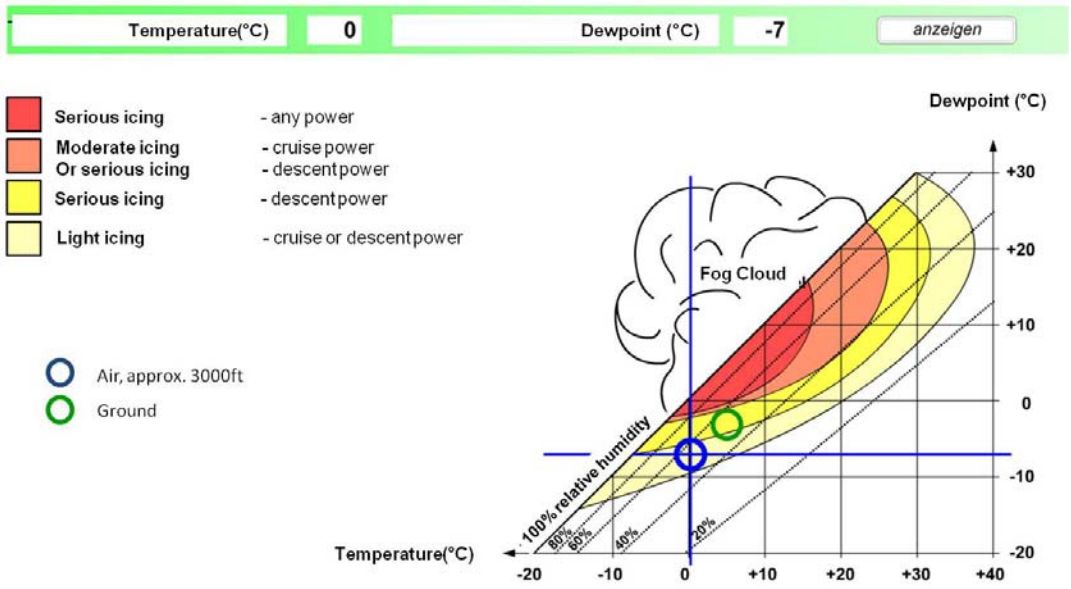

Figure 3: Probability of carburettor icing on 24.03.2009
(Source: SPHAIR training document)

1.3 Aircraft information

1.3.1 Piper PA-28-161 Warrior III aircraft, registration HB-PPG

Aircraft type	PA-28-161 Warrior III
Characteristics	Low-wing four-seater, full metal construction, tricycle fixed landing gear.
Manufacturer	The New Piper Aircraft Inc., USA
Serial number	2842012
Year of manufacture	1996
Operating hours:	7119:55 hours TSN[1]
Fuel grade	Aviation gasoline AVGAS 100LL
	The analysis of the fuel indicated that it complied with the specifications.
Fuel	The aircraft was carrying sufficient fuel for the flight.
Mass and centre of gravity	At the time of the accident , the mass and centre of gravity were within the allowable limits.
Registration certificate	Issued by the FOCA on 24 August 2007 / no. 3.
Airworthiness certificate	Issued by the FOCA on 24 August 2007, valid until revoked.
Airworthiness review certificate	Date of issue: 4 September 2008. Date of expiry of validity: 30 August 2009.
Operating range	Private: VFR day and night. Commercial: VFR day.

1.3.2 Engine

Type	O-320-D3G, s/n L-10235-39A
Manufacturer	Lycoming Engines, USA
Characteristics	4-cylinder horizontally opposed engine, air-cooled
Year of manufacture	Unknown
Operating hours	10766:22 hours TSN, 2018:39 hours TSO[2], TBO[3] 2000 hours.
Rated power	160 HP (119.4 kW) at 2700 RPM.
Magnetos	SLICK, LH P/N 4371, S/N 04031684, RH P/N 4370, S/N 04031471.
Spark plugs	Champion REM 38E. During the 1000-hour engine check, all eight spark plugs were replaced.

[1] TSN: Time Since New

[2] TSO: Time Since Overhaul

[3] TBO: Time Between Overhaul

1.3.3 Propeller

Type	74DM6-0-60, s/n A56410
Characteristics	Twin-blade fixed propeller, metal construction
Manufacturer	Sensenich Propeller Manufacturing Co. Inc., USA
Operating hours	4759:34 hours TSN, 1368:01 hours TSO

1.3.4 Carburettor

Type	MA-4SPA, p/n 10-5217, s/n CK816499
Manufacturer	Precision Airmotive Corp., USA

1.3.5 Maintenance

Maintenance was performed by FAST Aero Space Technologies AG at Grenchen aerodrome. Based on their work reports:

- The last 1000-hour check on the airframe was attested on 26 February 2009 at 7055:14 hours TSN.
- The last 1000-hour check on the engine was attested on 27 February 2009 at 10,702:11 hours TSN or 1953:25 hours TSO. In the work report, the item B.23 "*Inspect condition of carburettor heat air door and box*" was checked and signed.
- The last 50-hour check on the engine was attested on 20 March 2009 at 10,753:20 hours TSN or 2004:34 hours TSO. In the work report, the item B.23 "*Inspect condition of carburettor heat air door and box*" was checked and signed.

In the maintenance report, the following text was signed by the operator on 23 March 2009:

"*I have noted that the time between overhaul recommended by the manufacturer for this engine has been exceeded by 4 hours. I have decided to continue to operate this engine without an overhaul*."

1.4 Technical examination of the aircraft and engine

1.4.1 Examination of the aircraft

The aircraft was damaged as a result of the collision with the pasture fence. The wires of the fence were torn and coiled up by the spinning propeller.

The leading edges of both wings were damaged by the collision with the fence posts, as was the propeller spinner.

Approximately two hours after the emergency landing the engine was restarted by the mechanics who had arrived in the meantime. The engine started immediately.

In the two tanks a quantity of fuel in excess of 10 US gal was found.

In a comprehensive engine runup the next day, all functions of the engine were checked and the following findings were made:

- Operation, power:
  Operation of both ignition systems, power output and fuel pressure were in order. Engine acceleration from idle to full power following a rapid increase in power setting was remarkably slow.

- Carburettor heater:
  Only a small loss of engine speed was apparent when the carburettor heater was activated. An average drop in engine speed of only 40 rpm could be observed, both at 2000 rpm (speed for engine check) and at full power; according to the airplane flight manual (AFM) this should typically be 75 rpm during the engine check.

1.4.2 Examination of the engine

Following the engine runup, the engine was disassembled and examined for any technical faults which might have caused the accident. The following findings were made:

- Inspection of the engine:

  An engine compression test was carried out; the values were within the tolerances. A disassembly was carried out by a specialised company to allow a detailed inspection. All moving parts of the engine, as well as the four cylinders, the inlet and exhaust valves were checked and measured. All components were found to be in a condition consistent with the number of flight hours and appeared to be in working order.

- Magnetos:

  The two magnetos were tested on the test bench and no malfunction was detected. All measurements were within the limits specified by the manufacturer.

- Spark plugs:

  The upper spark plugs were visually in order; the lower spark plugs were heavily leaded. All the plugs functioned when tested on a test bench.

- Inlet pipes:

  The seals, which connect the intake pipes to the cylinders, exhibited cracks and leaks.

- Carburettor heater air door and box:

  The mechanism that allows switching of the intake air from normal operation to heating exhibited signs of wear. The flap had a lot of play; in addition, the seals which are supposed to seal the flap against the housing were missing. Some of the rivets which hold the flap together were loose; one rivet was missing and could not be found (cf. figures 4 and 5).

Figures 4 and 5: Flap, carburettor heater in assembled and disassembled condition

1.4.3 Examination of the carburettor

On the carburettor, the following findings were made:

- Accelerator pump injection tube:
  In the carburettor, the brass "idle tube", which is designed to inject additional fuel during rapid throttle transitions to full power was missing. It could not be found anywhere, nor was it possible to determine how long this tube had been missing. The accelerator pump with the "idle tube" improves the acceleration behaviour of the engine during rapid advances of the throttle.
- Float chamber:
  The plastic float which regulates the supply of gasoline in the carburettor was airtight; however, it had insufficient clearance from the float chamber, which meant that the float was able to intermittently come into contact with the chamber. This was confirmed by abrasion marks. As a result, the correct functioning of the carburettor might have been adversely affected.

1.5 Aircraft manufacturer's operating procedures

In the aircraft manufacturer's flight manual (AFM), chapter 3, section 3.31 Engine Roughness, it is stated that rough engine running is caused predominantly by carburettor icing.

Specifically, the following instruction is given there:

"Note:
Partial carburettor heat may be worse than no heat at all, since it may melt part of the ice which will refreeze in the intake system. Therefore when using carburettor heat always use full heat; and, when ice is removed, return the control to the full cold position."

Excerpt from AFM, chapter 4, Section 4.29:

"POWER OFF

If a prolonged power off descent is to be made, apply full carburetor heat prior to power reduction. If icing conditions are suspected. Throttle should be retarded and mixture control leaned as required. Power response should be verified approximately every 30 seconds by partially opening and then closing the throttle (clearing the engine). When leveling off, enrichen mixture, set power as required and select carburetor heat off unless icing conditions are suspected."

2 Analysis

2.1 Technical aspects

2.1.1 Effect of carburettor icing

The aircraft's carburettor heating-system had a significantly smaller effect than usual. This can essentially be explained by the poor condition of the flap in the airbox. As a result, carburettor icing may have been possible even if the carburettor heating had been applied correctly in accordance with the procedures. Effectively, the crew was only able to apply the carburettor heat partially, which is expressly discouraged in the AFM (cf. section 1.5) because this may cause icing in other parts of the inlet system.

The increase in power during the go-around, i.e. with throttle fully open, leads to a temperature rise in the inlet, which may cause existing ice deposits in the carburettor and intake system to melt. This may cause very rough running or vibration and significant loss of power.

2.1.2 Assessment of the engine

All components were found to be in a condition consistent with the number of flight hours and appeared to be in working order.

The above-mentioned engine wear in the spark plug and float chamber areas cannot directly explain the loss of power.

During the touchdown and landing roll the propeller continued to turn and consequently coiled up the wires of the pasture fence. From this it can be concluded that the engine did not stop completely but continued to idle, possibly until the coiled wires stopped the engine.

2.1.3 Assessment of the maintenance

According to the aircraft's technical documentation, maintenance was carried out in accordance with the manufacturer's documentation. However, the defects described in section 1, in particular the defective carburettor heating, were not detected. This is surprising, since this specific point was signed off as part of the last two checks.

2.2 Human and operational aspects

2.2.1 Carburettor icing

At the time of the accident, the weather conditions facilitated carburettor icing.

When the simulated emergency landing was initiated, carburettor heating was activated simultaneously with the power reduction and switched off again when the go-around was initiated. Because of the reduced effectiveness of the carburettor heating system explained above, this procedure was very unlikely to prevent the occurrence of carburettor icing.

The aircraft manufacturer describes in the AFM the procedure for prolonged power off descents. The recommended periodic check of the power response could have indicated an engine failure during the descent. However this was not relevant in the actual case, since the engine provided power at the initiation of the go-around.

2.2.2 Emergency landing

Flying a 180 degree turn following power loss directly after take-off or a go-around is in contradiction with the flight procedures usually instructed and represents a very challenging manoeuvre. The obstacles directly ahead (a row of trees, a high-voltage power line) forced the flight instructor to carry out this manoeuvre. Its successful completion was favoured by the relatively early go-around after the simulated emergency landing exercise and the resulting altitude which was somewhat higher than normal. The risk of a stall during such a manoeuvre is high. Thanks to the instructor's flying experience, this could be avoided.

2.3 Summary

The following aspects permit the conclusion that the loss of power had been very probably caused by carburettor icing:

- The prevailing weather conditions.
- The descent with idle power.
- The poor condition of the carburettor heating mechanism.

In addition, it was possible to re-start the engine after the accident.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- Up to the simulated emergency landing exercise the flight progressed uneventfully and the engine functioned without problems.
- There was sufficient fuel onboard for the planned flight.
- The analysis of the fuel indicated that it complied with the specification.
- During the climb after the simulated emergency landing, the engine suffered a loss of power at approximately 400 ft AGL.
- Approximately two hours after the emergency landing, the engine was restarted without any problems.
- The effectiveness of the carburettor heating during the engine runup carried out after the accident was significantly less than described in the AFM, resulting in reduced protection from carburettor icing.
- The detailed investigation of the engine revealed a relatively poor condition of the intake system, the carburettor heating, the carburettor and the spark plugs.

3.1.2 Operational aspects

- The aircraft was licensed for day and night VFR traffic.
- The flight instructor and trainee were in possession of the necessary licences and medical certificates.
- The mass and centre of gravity were within the permitted limits.
- The flight instructor managed to fly the aircraft in a tight left turn back towards the area of Bellechasse airfield. However, he was unable to avoid a collision with a pasture fence.

3.1.3 Environment

- The meteorological conditions at the time of the accident favoured carburettor icing, particularly during the idle power descent as part of the simulated emergency landing exercise.

3.2 Causes

The accident is attributable to a collision with obstacles after an emergency landing because of a loss of engine power The loss of power was most likely caused by carburettor icing.

The poor technical condition of the carburettor heating contributed to the loss of power.

Payerne, 4 October 2012 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, 18 September 2012

Annexes

Annex 1: Weather overview and Payerne radio probe

Tuesday 24.3.2009