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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2160 by the Swiss Accident Investigation Board SAIB

concerning the accident involving the Piper PA-32R-300 aircraft, registration HB-PRE

on 26 August 2010

Oey, Saanen/BE municipality

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Ursachen

Der Unfall ist darauf zurückzuführen, dass es kurz nach dem Start zu einer Kollision mit dem Gelände kam, weil das Flugzeug wegen einer markant reduzierten Leistungsfähigkeit des Motors nicht genügend an Höhe gewinnen konnte. Der Leistungsverlust des Motors erklärt sich aufgrund von Korrosions- und Verschleissschäden an der Nockenwelle und den *tappet bodies*.

Zum Unfall beigetragen haben:

- Die Fortsetzung des Starts trotz reduzierter Motorleistung.
- Das Nichtbeachten der Empfehlungen des Herstellers betreffend der bekannten Korrosionsproblematik im Motor.
- Die Nicht-Integration der entsprechenden Empfehlungen des Herstellers in das Unterhaltsprogramm des Motors.

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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 stated in local time (LT). At the time of the accident, Central European Summer Time (CEST) applied as local time in Switzerland. The relation between LT, CEST and coordinated universal time (UTC) is:
LT = CEST = UTC + 2 hours

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Final Report

Synopsis

Owner	Swiss Aviation Services AG, Hinterbergstrasse 26, PO Box 5052, 6330 Cham, Switzerland
Operator	Bodanair AG, Sonnhaldenstrasse 8, 8280 Kreuzlingen, Switzerland
Manufacturer	Piper Aircraft Inc., 2926 Piper Drive, Vero Beach, FL 32960, USA
Aircraft type	PA-32R-300 "Cherokee Lance"
Country of registration	Switzerland
Registration	HB-PRE
Location	Oey, Saanen/BE municipality
Date and time	26 August 2010, approx. 13:15

Investigation

The accident occurred at approx. 13:15 UTC and the Aircraft Accident Investigation Board (AAIB) was informed shortly afterwards. The investigation was opened on the same day at approximately 15:00 by the AAIB in cooperation with the cantonal police of Bern. The AAIB informed the United States authorities about the accident; the latter appointed an accredited representative and assisted in the investigation.

The present final report is published by the SAIB, formerly the AAIB.

Summary

On 26 August 2010 the pilot of the PA-32R-300, registration HB-PRE, intended to make a private flight with two passengers from Saanen (LSGK) to Zurich (LSZH).

Shortly before 13:00 the pilot started the engine and taxied to the holding point for runway 26. During the run-up and then also during the take-off roll, unusual noises, similar to misfirings, could be heard. With a take-off roll distance of about 800 m, HB-PRE took an unusually long time before it finally lifted off. The aircraft subsequently gained hardly any height and passed over the end of the runway at a low altitude. Shortly afterwards, the aircraft crashed into a pile of driftwood near the Saanen ARA[1]. The aircraft immediately caught fire and was partially burnt out.

All the occupants were fatally injured and the aircraft was destroyed. There was slight damage to the field.

Cause

The accident is attributable to the fact that shortly after take-off a collision with the terrain occurred because the aircraft was unable to gain sufficient height as a result of significantly reduced engine power. The loss of engine power can be explained by damage due to corrosion and wear on the camshaft and tappet bodies.

The following factors contributed to the accident:

- Continuation of the take-off despite reduced engine power.
- Non-compliance with the manufacturer's recommendations concerning the known corrosion problems in the engine.
- Non-integration of the corresponding manufacturer's recommendations in the engine maintenance programme.

[1] ARA - Abwasser Reinigungsanlage (waste water treatment plant)

1 Factual information

1.1 Pre-history and history of the flight

1.1.1 General

The perceptions of various witnesses were used for the following description of the pre-history and history of the flight.

The flight took place under visual flight rules. This flight was declared as a private flight on the flight notification.

1.1.2 Pre-history

The pilot of HB-PRE was requested on 26 August 2010 to fly a couple who were known to him from Saanen (LSGK) to Zurich (LSZH) on 26 August 2010, so that these two persons could make a scheduled flight from Zurich to Hamburg at 14:55. The pilot planned to use the Piper PA-32R-300, registration HB-PRE, for this purpose. He had acquired this aircraft about a year earlier in Germany and imported it into Switzerland.

On the morning of the day of the accident, the pilot refuelled HB-PRE with 97 litres of aviation fuel and prepared the aircraft for the planned flights. HB-PRE took off from runway 28 in Altenrhein at 11:18 and exited the control zone via reporting point ZULU. At 12:30 HB-PRE was approaching Saanen. During the final approach on runway 26, several people on the ground noticed HB-PRE because of its rather unusual engine noise for this type of aircraft. After landing, the aircraft taxied onto the apron. Since nobody was in the C-Office because of the lunch break, the pilot completed the usual formalities at the entrance to the office, filling out the appropriate envelope together with the flight notification.

1.1.3 History of the flight

The aerodrome manager and his employees returned from their lunch break between 12:50 and 12:55. They saw three people board the PA-32R-300. The pilot called the aerodrome manager stating that he had inserted the landing fee into the envelope and said goodbye with the words: "We have to go." The Saanen aerodrome personnel then went to the C-Office.

Shortly afterwards, they heard the pilot of the PA-32R-300 trying to start the engine several times. It then suddenly started up and the aircraft taxied immediately towards the 'traffic light' at the eastern corner of the apron. An employee in the C-Office noted this and instructed the pilot to wait there until an approaching Beech King Air had landed on runway 26. The pilot of HB-PRE acknowledged this instruction. After the twin-engine Beech had rolled out on the runway past the waiting PA-32R-300, the employee in the C-Office transmitted to the pilot in HB-PRE, that he could now continue taxiing to the holding point for runway 26. Take-off preparations began when the aircraft reached the holding point.

An experienced private pilot who was sitting on the balcony of his chalet in Saanen "Unterbort" became aware of the aircraft because the engine was spluttering unusually during the run-up. He described this as misfirings. He now observed HB-PRE more closely as it lined up on runway 26. The flaps were extended. When take-off power was set, the engine sounded normal. After the aircraft had had rolled approximately 100 m, he again heard distinct misfiring. The aircraft accelerated very slowly and shortly disappeared from his view behind a former military building. He then saw the aircraft rotate and lift off approximately abeam the apron.

Various persons in the area of the apron and the employees in the C-Office became aware of the aircraft, which was flying unusually low. The landing gear was immediately retracted. However, HB-PRE gained hardly any altitude and flew above the runway towards the end of the runway. The angle of attack increased continuously, but the altitude increased only slightly. The aircraft was flying along the runway axis when it passed the end of the runway. The aircraft cleared the tree line between the end of the runway and the river Saane by 5-10 ft. The Piper turned slightly to the right with a pronounced nose-up attitude, as it would probably not have been able to clear the hill "Vanel", beyond the Saanen waste water treatment plant. The aircraft subsequently began to lose height. The pilot did not respond to radio calls from the C-Office. In a short, probably involuntary radio message, only the words: "... ah, ahh...neii [Oh, no]" were heard from the loudspeaker.

A worker at the waste water treatment plant became aware of the aircraft flying low from the aerodrome and heard the engine spluttering. He also observed how the angle of attack constantly changed. Above the septic tanks the aircraft continued to turn to the right and crashed into a stack of driftwood right next to the septic tanks. He immediately ran to the scene of the crash and saw thick smoke rising from the wreckage. The occupants were motionless.

When the smoke became visible to the persons in the C-Office, the alarm was immediately given. Two waste water treatment plant employees had to give up on their initial attempts to extinguish the fire after two large flash fires erupted. The aircraft was partially burnt out such that the occupants could not be rescued from the flames. The local fire brigade was finally able to extinguish the fire .

1.1.4 Accident location

Accident location	Oey, Saanen/BE municipality 1.4 km west of Saanen airport (LSGK)
Date and time	26 August 2010, approx. 13:15
Coordinates	584 037 / 148 316 (Swiss grid 1903) N 46° 29’ 10’’ / E 007° 13’ 51’’ (WGS 84)
Elevation	995 m AMSL 3264 ft AMSL
Final position of the wreckage	655 m west of the begin of runway 08 and 195 m north of the extended runway centerline of the Saanen aerodrome
Map of Switzerland	Sheet no. 1245, Château-d’Oex, Scale 1:25,000

1.2 Injuries to persons

1.2.1 Injured persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	1	2	3	0
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	Not applicable
Total	1	2	3	0

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

Slight damage to the field occurred.

1.5 Personnel information

1.5.1 Flight crew

1.5.1.1 Pilot

Person	Swiss citizen, born 1962
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 15 March 1995
Ratings	Type rating AVRORJ/BAe 146 as pilot in command, valid till 24 November 2010 Class rating for single-engine piston, valid till 12 January 2012 International radiotelephony for flights under visual and instrument flight rules RTI (VFR/IFR) Night flight NIT
Instrument flying rating	Instrument flight aircraft IR(A) Category III instrument approaches with AVRORJ/BAe 146, last extended on 23 November 2009, valid till 24 November 2010
Medical fitness certificate	First class, without restrictions, valid till 20 May 2011
Last medical examination	10 May 2010
Begin of pilot training	1988

1.5.1.1.1 Flying experience

Total	10,751:12 hours
on the accident type	05:46 hours
during the last 90 days	135:49 hours
of which on the accident type	2:09 hours
during the last 24 hours	1:27 hours
of which on the accident type	1:27 hours
Total no. of landings	Unknown
Landings during the last 90 days	105
Landings, total, on the accident type	9
Landings during the last 90 days on the accident type	2

1.5.1.1.2 Renewal of the rating for single-engine piston engine aircraft

On 11 January 2010 the pilot renewed his rating for single-engine piston aircraft (SEP). In the process, he claimed, among other things, that in the 12 months before this rating expired he had completed 21:30 hours, 20 take-offs and 20 landings as pilot in command on class SEP aircraft.

Since this renewal up to the time of the accident he flew as pilot in command on class SEP aircraft for 7:40 hours and completed 11 take-offs and 11 landings.

1.5.2 Passengers

Female German national, born 1947, no flying experience.
Male German national, born 1949, no flying experience.

1.6 Aircraft information

1.6.1 General information

Registration	HB-PRE
Aircraft type	PA-32R-300 "Cherokee Lance"
Characteristics	Single-engine, six-seat light aircraft with piston engine, constructed as a self-supporting low-wing aircraft, full metal construction with retractable landing gear in tricycle configuration
Manufacturer	Piper Aircraft Inc., 2926 Piper Drive, Vero Beach, FL 32960, USA
Year of manufacture	1976
Serial number	32R-7780071
Owner	Swiss Aviation Services AG, Hinterbergstrasse 26, PO Box 5052, 6330 Cham, Switzerland
Operator	Bodanair AG, Sonnhaldenstrasse 8, 8280 Kreuzlingen, Switzerland

Engine	Lycoming Textron USA, LYC IO-540-K1G5D[2], four-stroke boxer engine, with six cylinders and fuel injection without supercharger Serial number L-15551-48A, year of manufacture 1976, nominal output 224 kW (300 PS)
Propeller	MT-Propeller Entwicklungs GmbH, Flugplatzstr. 1, 94348 Atting, Germany Hydraulically adjustable three-blade propeller, composite construction, constant speed Type MTV-9-B/198-52, serial number 06586, year of manufacture 2006
Equipment	The aircraft had equipment which would have met the requirement for flights under instrument flight rules. This equipment therefore meets the conditions according to the certification of this aircraft for VFR flights
Operating hours	Airframe: 1256:34 hours TSN[3] Engine 1256:34 hours TSN Propeller 87:57 hours TSN
Number of landings	2169
Max. permitted masses	Max. permitted take-off and landing mass 1633 kg (3600 lb)
Mass and centre of gravity	The mass of the aircraft at the time of the accident was 1356 kg (2989 kg) Both the mass and centre of gravity were within the permitted limits according to the aircraft flight manual (AFM).
Technical limitations	None known, since the aircraft log was destroyed in the fire. The technical records were on board and were partially destroyed by fire
Permitted fuel grade	Aviation fuel AVGAS 100LL
Fuel grade at the time of the accident	According to the analysis, the fuel met the specifications for aviation fuel AVGAS 100LL
Fuel reserves	At the time of the accident there were still approx. 28 USG in the tanks. This corresponds to a flying time reserve of approximately 1:40 hours
Registration certificate	Issued by the FOCA on 18 August 2009, valid till removal from the aircraft register

[2] According to type rating plate, IO-540-K1A5D according to FOCA aircraft register
[3] TSN - time since new

Airworthiness certificate	Issued by the FOCA on 20 November 2009, valid till revoked
Certification of airworthiness inspection	Date of issue: 9 December 2009 Date of expiry of validity: 19 November 2010
Certification	Private
Category	VFR day and night

1.6.2 Engine information

The engine fitted to HB-PRE has six cylinders. Each of these cylinders has one exhaust valve and one inlet valve. The exhaust valves of the six cylinders are individually controlled by the corresponding exhaust valve cam on the camshaft; the inlet valves of two opposing cylinders are controlled by a single common inlet valve cam on the camshaft. The actuation of the valves is shown below in diagrammatic form:

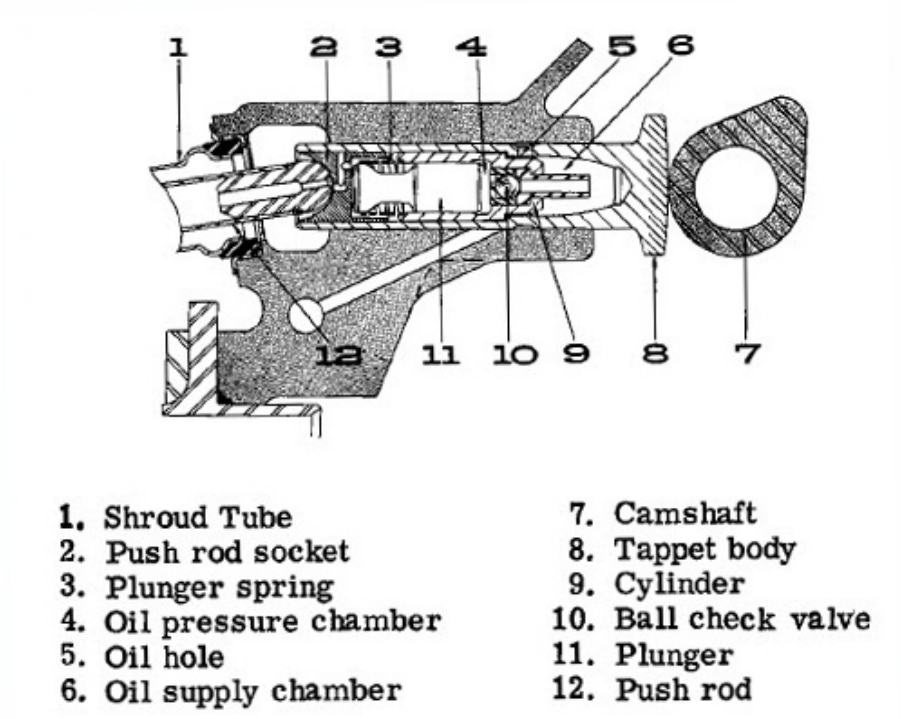

Figure 1: Illustration of valve control, from the Lycoming overhaul manual

1.6.3 History of the aircraft

The PA-32R-300 with the serial number 32R-7780071 was ferried to Germany from the USA as N7648F. This aircraft was then put into service from 17 December 1976 registered as D-EHKM. At this point, the aircraft had 27 operating hours.

On 2 October 1998 the 1000-hour inspection on the PA-32R-300 was attested at an operating time of 973 hours. This resulted in an annual average of approximately 44 operating hours over this period.

On 29 August 2008 an annual inspection was attested in Germany, together with a 100-hour inspection. At that time the aircraft had logged 1246:24 operating hours. The last owner in Germany sold D-EHKM on 20 April 2009 to Bodanair AG in Kreuzlingen. At this time the aircraft had 1250:49 operating hours. The annual average of operating hours fell between 1998 and 2009 to approximately 25 hours.

In the last year of operation since its import into Switzerland, the aircraft PA-32R-300, now registered as HB-PRE, was only operated for approximately 4 hours.

1.6.4 Import and maintenance in Switzerland

On 14 July 2009 D-EHKM was flown to Altenrhein (LSZR). The technical records for HB-PRE were established on 20 August 2009. The ARC issued by the German Federal Aviation Authority[4] was valid till 19 September 2009. According to information from the FOCA, the submission of the required documents was delayed for unknown reasons, to the extent that the ARC was no longer valid at the time of the final registration of this aircraft as HB-PRE. The FOCA therefore decided on 28 September 2009 that an entry in the aircraft register would only be possible if a CAMO[5] carried out a full airworthiness review and subsequently issued a corresponding recommendation.

This process was carried out by the Altenrhein Aviation AAL company. In addition, the technical records attested that the airframe was subject to a 100-hour inspection and the engine to a 400-hour inspection at 1253:25 operating hours. This work was carried out between 19 October and 13 November 2009. However, no confirmations of work done were found in the technical records of the engine. The implementation of the airworthiness review was attested in the technical records on 18 November 2009. The acceptance inspection, based on the recommendation of the CAMO Altenrhein Aviation AAL, was conducted by the FOCA on 19 November 2009, so that the airworthiness certificate was issued on 20 November 2009.

The correction of the findings during the airworthiness review was attested on 20 January 2010.

Up to the time of the accident no confirmations relating to other maintenance work were found in the technical records of HB-PRE.

[4] ARC - airworthiness review certificate

[5] CAMO - continuing airworthiness management organization

1.6.5 Maintenance items not carried out

From the last 100-hour inspection up to the time of the accident, the following maintenance items were due:

- Monthly: inspect battery, box or shelf and cables. Check portable fire extinguisher for condition & charge.
- Every three months: remove drain and clean fuel strainer bowl and screen, located in bottom of fuel selector valve.
- Every four months: Lycoming mandatory service bulletin (SB) 480E: oil and filter change and screen cleaning.

No evidence proving that this work had been performed was found in the technical records.

With regard to the SB 480E, the maintenance company commented as follows [translated from German]: "...this is the operator's responsibility. According to the AAL internal planning list, the oil and filter change was due at 1303 hours / 13.03.2010. AAL changed the oil and filter during the annual inspection of Nov. 2009 and was never subsequently instructed by the operator to carry out any further oil and filter changes."

1.6.6 Engine overhaul

In the 'sixties, Lycoming published the Overhaul Manual Direct Drive Engine in which the work instructions for overhauling Lycoming engines were described. In the current sixth edition, dated 1974 with the revision status of July 2008, the corrosion problem, also described in this report, is referred to as follows:

"6-43. HYDRAULIC TAPPET BODIES. If for any reason a new camshaft is to be installed in the engine, or the cam lobes are conditioned by regrinding, all of the tappet bodies must be discarded and replaced with new tappet bodies. (…)

6-45. Check the face of the tappet body for signs of spalling or pitting (figure 6-17). Any face which shows this condition is cause for rejection, and the tappet body must be replaced with a new tappet body. It is recommended, that a magnifying glass (min. 10 power) be used for this purpose.

6-46. When a tappet body is rejected because of spalling, a visual inspection of the nose of the cam lobe with a magnifying glass (min. 10 power) must be made.

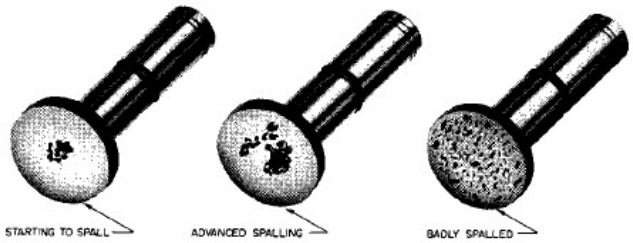

Figure 6-17. Appearance of Spalling Marks on Face of Hydraulic Tappet Bodies

Any indication of distress, surface irregularity or feathering at the edge of the lobe is cause of rejection of the cam shaft."

In 2009, Lycoming also published the Service Instruction no. 1009AU. This document was first published in 1960. The following information in particular can be found in this document:

"…Continuous service assumes that the aircraft will not be out of service for any extended period of time. Refer to latest revision of Service Letter no. L180 if the aircraft is to be out of service for a period of time greater than 30 days.

Engine deterioration in the form of corrosion (rust) and the drying out and hardening of composition materials such as gaskets, seals, flexible hoses and fuel pump diaphragms can occur if an engine is out of service for an extended period of time. Due to the loss of a protective oil film after an extended period of inactivity, abnormal wear on soft metal bearing surfaces can occur during engine start. Therefore, all engines that do not accumulate the hourly period of time between overhauls specified in this publication are recommended to be overhauled in the twelfth year…"

For the engine type installed in HB-PRE, in addition to the calendar term of twelve years, this document also specifies a recommended TBO[6] of 2000 operating hours.

There is no evidence in the technical records that the engine of the PA-32R-300 involved in the accident had undergone an overhaul since it was brought into service.

1.6.7 Service Letter no. L180B

In 2001 the engine manufacturer published the Service Letter no. L180B. This document deals essentially with the conservation/preservation of engines with the aim of preventing corrosion. The following information, which also applies to the engine in HB-PRE, is described as follows:

"SUBJECT: Engine preservation for active and stored aircraft

Engines in aircraft that are flown only occasionally may not achieve normal service life because of corrosion. This occurs when moisture from the air and products of combustion combine to attack cylinder walls and bearing surfaces during periods when the aircraft is not used. The procedures for combating this condition consist of coating the vulnerable surfaces with rust inhibitive compounds as herein described.

NOTE

Need for preservation must be evaluated by the owner or operator of the aircraft based on environmental conditions and frequency of aircraft activity. The time periods given are recommendations based on normal conditions.

Our experience has shown that in regions of high humidity, active corrosion can be found on cylinder walls of new engines inoperative for periods as brief as two days. In engines that have accumulated 50 hours or more time in service in a short period, the cylinder walls will have acquired a varnish that tends to protect them from corrosive action; such engines under favorable atmospheric conditions can remain inactive for several weeks without evidence of damage by corrosion.

Aircraft operated close to oceans, lakes, rivers and in humid regions have a greater need for engine preservation than engines operated in arid regions.

[6] TBO - time between overhaul

ACTIVE ENGINES:

Engine temperature and length of operating time are very important in controlling rust and corrosion. The desired flight time for air cooled engines is at least one continuous hour at oil temperatures of 165°F to 200°F at intervals not to exceed 30 days, depending on location and storage conditions. This one hour does not include taxi, take-off and landing time. If recommended oil temperatures are not obtainable, contact aircraft manufacturer for availability of oil cooler winterization plates.

The aircraft temperature gages should be checked to make sure that they are accurate.

The cooling air baffles need to be in good condition and fitted properly to assure proper cooling air flow.

The oil cooler system needs to be of the proper size for the engine and airframe installation. Oil coolers that are sized incorrectly can cause over-heating or below minimum temperatures. Low temperatures are just as harmful as high temperatures due to build-up of water and acids.

Oil changes are very important in minimizing rust and corrosion. Reference latest revision of Textron Lycoming Service Bulletin no. 480 for recommended oil/filter change intervals and procedures.

Pulling engines through by hand when the aircraft is not run or flown for a week or so is not recommended. Pulling the engine through by hand prior to start or to minimize rust and corrosion does more harm than good. The cylinder walls, piston, rings, cam and cam follower only receive splash and vapor lubrication. When the prop is pulled through by hand, the rings wipe oil from cylinder walls. The cam load created by the valve train wipes oil off the cam and followers. After two or three times of pulling the engine through by hand without engine starts, the cylinders, cam and followers are left without a proper oil film. Starting engines without proper lubrication can cause scuffing and scoring of parts resulting in excessive wear.

INACTIVE ENGINES:

(…)"

1.7 Meteorological information

1.7.1 General

The information in sections 1.7.2 to 1.7.4 was provided by MeteoSchweiz and translated into English language.

1.7.2 General meteorological situation

A zone of high pressure determined the weather throughout the Alpine region. After the remaining banks of cloud had cleared in the early morning, there followed a sunny morning with good visibility.

1.7.3 Weather at the time and location of the accident

The following information on the weather at the time and location of the accident is based on a spatial and temporal interpolation of the observations of different weather stations.

Weather/cloud	1-2/8 residual cloud cover at altitude
Visibility	over 30 km

Wind	Variable, light wind
Temperature/dewpoint	30 °C / 10 °C
Atmospheric pressure:	QNH LSZH 1016 hPa, QNH LSZA 1016 hPa
Hazards:	Temperatures up to 30 °C

1.7.4 Astronomical information

Position of the sun:	Azimuth: 170°	Elevation: 54°
Lighting conditions	Daylight	

1.8 Aids to navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome information

1.10.1 General

Saanen aerodrome is located 2.8 km northwest of Gstaad in the Bernese Alps. It is situated in a basin between Saanen and Rougemont and was a military aerodrome until 1992.

The aerodrome was only used by civil aircraft at the time of the accident. Prior permission was required for landings (prior permission required - PPR). There was no air traffic control service at the aerodrome. The following hazards were referred to in the Swiss Aeronautical Information Publication - AIP (caution - CTN):

- Mountain aerodrome. Initiation flight advised.
- Summer: High density altitudes.
- Winter: It is necessary to inquire about the runway conditions by telephone.

The reference elevation of the airport is 3307 ft AMSL and the reference temperature is 20.7 °C.

1.10.2 Runway equipment

The asphalt runway of Saanen aerodrome could only be used for take-offs and landings under visual flight rules (VFR). Its dimensions were as follows:

Runway	Dimensions
08/26	1400 m (4593 ft) x 40 m

1.10.3 Take-off and landing distances

Runway	TORA[7] (m)	LDA[8] (m)
08	1080	1090
26	1090	1080

[7] Takeoff run available
[8] Landing distance available

1.10.4 Rescue and fire-fighting services

Saanen aerodrome was equipped with Category 1 fire-fighting resources. Category 2-4 could be made available subject to a prior request.

1.11 Flight recorders

A flight recorder was not prescribed and was not installed.

An EDM 800 electronic engine monitor was installed and its installation attested on 30 March 2006. The configuration of this installation could not be determined. Such a device made it possible to acquire up to 24 engine parameters and to record them at a rate of 4 Hz. The maximum recording duration was 30 hours.

There was no reference in the documentation to recordings and analyses of data from earlier flights.

No analysis of the EDM 800 could be conducted because of the extent of the damage.

1.12 Wreckage and impact information

1.12.1 Site of the accident

The site of the accident was on a meadow next to the Saanen waste water treatment plant.

Figure 2: Flight path (yellow arrow) and site of the accident (yellow circle)

1.12.2 Impact

The aircraft crashed onto a stack of driftwood which was being stored temporarily on the meadow next to the Saanen waste water treatment plant after the flooding of the river “Chalberhönibach” on 12 July 2010. This impact resulted in enormous deceleration values.

1.12.3 Wreckage

The aircraft was destroyed by the impact. The cockpit area with the instrument panel, as well as the passenger compartment, was completely burnt out. With the exception of the flaps and the fuel selector, it was not possible to make statements concerning switch positions and the position of the various controls in the entire cockpit area. At the time of the accident, the flaps were in the position 25° and the fuel selector was set to the left tank.

The fuselage was on its belly next to a four-metre high stack of driftwood.

The nose of the aircraft was pointing towards Saanen aerodrome. The two wings were separated from the fuselage. The engine was still attached to the fuselage. The underside of the engine exhibited major damage. On the engine oil filler opening the cap was missing; it could not be found at the scene. The upper engine cowling was approximately 5 metres from the engine at the site of the accident. No significant oil traces were found on the inside of the cowling. It can therefore be assumed that the cap was dislodged on impact and was flung away.

The ground in the area of the wreckage of the aircraft was soaked with water as a result of the fire brigade's fire-fighting operations. Fairly large quantities of oil/water mixture were found under the engine.

The left wing was wedged into the woodpile. In the area of both fuel tanks, on the outside and inside, the sheet metal of the top of the wing was destroyed by fire. No residual fuel was found in the two tanks.

In the integral fuel tank on the right wing, which was not consumed by the fire, some 25 litres of fuel was found.

All three propeller blades had broken off from the propeller hub. Parts of the propeller blades were found within a radius of 50 metres of the site of the accident.

The two main landing gear sections were in the wings and in the retracted position. When the right wing was recovered, its main landing gear moved towards the extended position. The nose landing gear was found separated from the front of the fuselage in the wreckage.

The fuel injector servo and the magneto exhibited pronounced traces of fire on the outside. Traces of fuel were found in the fuel system on the engine.

When the fuselage was recovered, a large quantity of badly scorched and partially charred documents were recovered behind the pilot’s seat.

Based on the examination of the jackscrew, it was possible to ascertain that the elevator trim was in a neutral position.

1.13 Medical and pathological information

After the accident the occupants were found in the following positions:

Pilot	Cockpit front left
Female passenger	Cockpit front right
Male passenger	Passenger compartment right

The bodies of the pilot and passengers underwent an autopsy. In the case of the pilot it was established that death occurred immediately as a result of the serious injuries sustained on impact. No evidence of pre-existing pathological changes in organs were found which would affect the pilot's ability to control of the aircraft.

The toxicological investigation was negative for alcohol, medicines and drugs.

The passengers died from the effects of the impact and the subsequent fire.

1.14 Fire

The aircraft caught fire after the impact and partially burnt out. Although various persons attempted to extinguish the fire at the wreckage shortly after the accident, it was not possible at this stage to fight the fire adequately in order to protect the occupants from the flames. The local fire brigades were finally able to extinguish the fire.

1.15 Survival aspects

1.15.1 General

The accident with the subsequent intense fire was not survivable.

1.15.2 Search and rescue

The aircraft was not equipped with an emergency transmitter (emergency location beacon aircraft – ELBA).

The installation of an emergency transmitter was the subject of a discussion between the maintenance company and the pilot and was accordingly offered by the maintenance company.

1.16 Tests and research

1.16.1 Examinations of the engine

The engine and its accessories exhibited major impact and fire damage. The engine was disassembled for inspection.

1.16.1.1 Disassembly for inspection

On the occasion of the disassembly for inspection, during which the general condition of the engine was assessed as poor, it was possible to measure or ascertain the following, among other things:

- A cold state compression measurement of the cylinders showed that cylinders 3, 4, 5 and 6 did not meet the requirements. An examination of the valve seals showed that only on cylinder 2 the inlet and exhaust valves were airtight.

- The spark plugs which were removed revealed the following:

	Lower plug			**Upper plug**		
Cylinder	Condition:	Lead	Burned-off	Condition:	Lead	Burned-off
1	fairly black	little	approx. 50%	slightly black	none	approx. 50%
3	slightly black	none	approx. 50%	slightly black	none	approx. 50%
5	very black	none	approx. 50%	very black	none	approx. 50%
2	fairly black oil traces, slightly moist	none	approx. 50%	fairly black	none	approx. 60%
4	slightly black	traces	approx. 60%	slightly black, slightly rusty	none	approx. 60%
6	very black	none	approx. 50%	very black	none	approx. 50%

- The spark plugs of cylinders 5 and 6 were heavily sooted up. No defects were found during the functional testing of all twelve spark plugs.
- When the cylinders were dismantled, it was found that cylinder no. 2 had already been dismantled, repaired and re-installed previously. This work was attested on 30 March 2006. The operating time of cylinder no. 2 since this repair up to the time of the accident was 98:27 hours.
- A repair was detectable on cylinder no. 1.
- Serious corrosion was visible on the inner wall of cylinders no. 3, 4, 5 and 6. The incidence of rust on the cylinder surfaces was striking. It was also found that the usual fine oil-film on the surfaces of the pistons and cylinders was missing; this may possibly be due to the fire.

Figure 3: Cylinders 5 and 6 exhibit pronounced corrosion on the cylinder wall

- The inner tubes of exhaust tubes 4, 5 and 6 were heavily blackened.
- Residual fuel was found in the inside of the inlet line to cylinder 5, near the injector nozzle aperture.
- With the exception of cylinders 1 and 2, all pistons exhibited considerable deposits of a mixture consisting of rust and oil on their bottom piston rings.
- On the camshaft, a wear of approximately 4 mm was found on the cam which actuates the inlet valves of cylinders 5 and 6.

Figure 4: Camshaft with damaged cam
(beschädigter Nocken=Damaged cam)

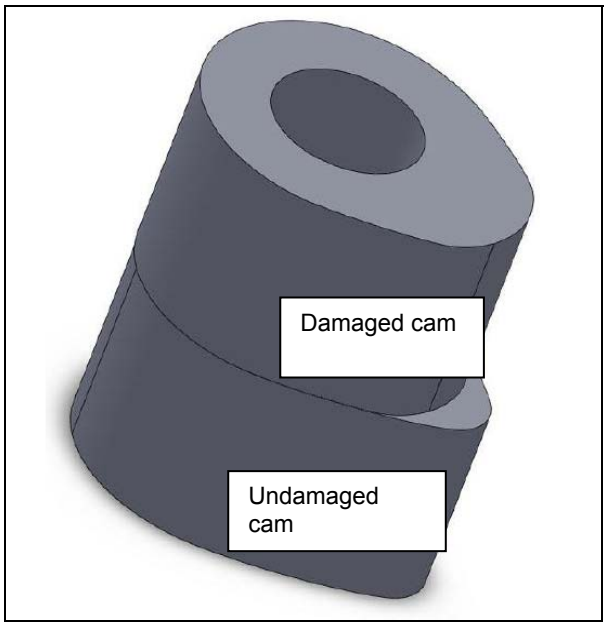

Figure 5: Comparison of the damaged cam with an undamaged cam

- The tappet bodies operated by the damaged cam to control the inlet valves of cylinders 5 and 6 were very badly corroded on the contact surface. In addition, the tappet body of the cylinder 4 exhaust valve was badly corroded.

Cylinder 4 tappet body exhaust	Cylinder 5 tappet body inlet	Cylinder 6 tappet body inlet
		

Figure 6: Corrosion on tappet bodies

- A large number of ferrous particles up to 1 mm in size were found in the oil sump.
- When the accessory housing was opened, it was found that the gears for driving the magnetos were incorrectly positioned, i.e. they were offset by one tooth. This offset could limit correct setting of the ignition timing.
- Examination of the push rod and hydraulic lifter revealed no defects.
- Measurement of the inlet and exhaust valve shafts and their guides produced a clearance of 0.14 mm instead of the maximum permissible value of 0.12 mm. No jamming of the exhaust valves could be observed.

1.16.1.2 Measurement of the camshaft

The camshaft was measured using a precision measuring machine.

The damaged cam exhibited a difference of 3.87 mm in comparison with the undamaged cam, i.e. the inlet valves of cylinders 5 and 6 were opened 3.87 mm less as a result of the worn shape of the cam.

The dimensions of the camshaft over four bearing positions indicated a straightness of 0.005 mm, the cylindrical shape a deviation of 0.0355 mm and the average diameter over all four bearing positions was 26.1056 mm.

All the undamaged cams exhibited a similar profile to within approx. 0.05 mm.

The hardness of the camshaft was measured at 15 points using the “Vickers” method[9]. The results at all measurement points, with the exception of those on the damaged cam, are between 600 and 700 HV. The damaged cam exhibited with 400HV a significant deviation.

1.16.1.3 Estimate of the loss of power due to a reduced cylinder filling

The fuel is mixed in the fuel injector servo according to the quantity of intake air and individually injected into the cylinder via a distributor. The performance of a fuel engine depends among other things on how the cylinder is filled with an ignitable fuel-air mixture. The filling degree and the performance of a cylinder are dependent on the opening cross-section and the opening time of the inlet valve.

[9] The British scientist after whom this hardness testing method was named.

For estimates, it can be assumed that in a piston engine the power loss is proportional to the reduction in the filling degree of the cylinders.

In the present case this means that the power loss of the cylinder in a piston engine is proportional to the reduction in the valve stroke - for a constant valve opening time. In reality, the performance loss is somewhat greater, due to the constant friction in the engine. This statement only applies if, the mixture in the cylinder is ignitable, despite of incomplete filling.

Based on the measured data, the following values apply to the inlet valves of cylinders 5 and 6 (taking into account 0.1 mm valve clearance and transmission elasticity):

Maximum valve lift	4.80 mm
Mean valve lift	1.71 mm

The measurement data for the unworn cams is as follows:

Maximum valve lift	8.95 mm
Mean valve lift	2.52 mm

The loss of power can be estimated from the measured data. In the best case it is 15% to 20% for the 6-cylinder engine with the worn inlet valve cam on cylinders 5 and 6 ; this holds true on the condition that the existing mixture in these cylinders is ignitable.

In the worst case, i.e. if the mixture in cylinders 5 and 6 is not ignitable, a much greater loss of power could be expected. This occurred on several occasions in the present case, before and during the take-off of HB-PRE when various occurrences of misfiring were noticed. In these phases, the mixture was partially too rich and therefore not ignitable.

1.16.1.4 Examination of the accessories

An examination of the magnetos, the fuel injection system and the oil pump produced the following results:

The examination of the magnetos which was still possible to perform revealed no evidence of possible pre-existing defects.

The fuel injection system of the Precision Airmotive RSA 10ED1 type with P/N 2524273-11 and serial number 67028 did not correspond to the modification status applicable to this type at the time of the accident. No evidence that AD 2009-02-03, RSA-5 or RSA-10 "fuel injector servo plug" had been carried out was found in the technical records.

The manufacturer Precision Airmotive LLC issued the following comments regarding maintenance of the system:

"We have no record of this servo ever having been at the Precision Airmotive facility. The serial number indicates it was built by Bendix some time before Precision purchased the product line in 1988. The P/N indicates it was overhauled in the early 1980s. We currently recommend overhaul every ten years, regardless of operating time. This is covered by our Service Bulletin PRS-97."

Functional testing of the fuel injection system was not possible because of its condition after the accident.

When the oil pump was dismantled, wear was found on the teeth of the pump wheels and the wall of the body. This damage may also have been caused by,

among other things, metallic residues in the oil. A function test could no longer be carried out on the oil pump.

1.16.1.5 Propeller hub and governor

The examination of the propeller hub and governor established that the propeller blades were in the position low pitch angle at the time of the accident. This corresponds to the position recommended by the manufacturer for take-off and landing.

1.16.2 Comments of the engine manufacturer on the damage found

On request, the engine manufacturer commented on the damage found in the engine as follows.

Extract from the comments:

"…Yes, we have seen many engines with wear and spalling to the camshaft lobes and tappet faces.

This wear occurs over a period of time. Long periods of non-use (aircraft not being flown), then several flights and then more non-use time with no or very few oil changes will accelerate this wear.

As mentioned above, periods of non-use, then short periods of use, followed by non-use again. This is a 34 yr old engine with only 1,253:25 hrs on it. This is an average of only 37 hrs per year.

Lycoming's recommended Time Between Overhaul (TBO) is 2,000 hrs or 12 calendar years as referenced in Service Instruction 1009AU. This engine is three times the recommended 12 calendar years.

Yes, the method is regular oil changes as per Service Bulletin 480E with an emphasis on never to exceed four calendar months. If the filter and screens are checked at each oil change small bits of metal will be found and the maintenance base would note an increase in metal and at some point when it was found to be increasing rapidly the engine should be opened up for inspection. This could be as simple as removing a couple of cylinders and inspecting the camshaft lobes and tappet faces.

There is no doubt this cam lobe and tappet wear was caused by periods of non-use, not doing regular oil changes, and not doing good inspections of the oil filters or screens."

1.17 Organisational and management information

1.17.1 Bodanair AG

The company Bodanair AG was founded in 2005 with the purpose of commercial transport of persons and goods by the pilot involved in the accident.

In order ultimately to be able to offer commercial flights, corresponding approval from the FOCA is required. Acquisition of this approval was envisaged by Bodanair AG. Up to the time of the accident, there is no evidence to suggest that the process to obtain this approval had been initiated.

At the time of the accident, Bodanair AG operated two aircraft, which were also chartered to third parties. There were various projects to operate larger aircraft in the future. The owner of the company was seeking investors in these projects.

As far as is known, the owner of Bodanair AG was the only employee of the company.

1.17.2 Federal Office of Civil Aviation

1.17.2.1 General

The Federal Office of Civil Aviation (FOCA) is responsible for monitoring civil aviation in Switzerland and aviation development. . The FOCA is part of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).

The FOCA is responsible for the fields of:

- Flight operations
- Aviation personnel
- Aircraft
- Infrastructure
- Aviation policy

Among other things, the aircraft sector covers on the one hand the certification of new aircraft and components and on the other hand the aircraft maintenance.

Maintenance work is periodically required to maintain the airworthiness of an aircraft. Requirements for maintenance work are laid down both by the manufacturing companies and in the national and international technical standards.

Maintenance companies in Switzerland require an authorisation by the FOCA. In this context, the Office checks whether the organisation and the technical personnel meet the necessary requirements. Companies with an authorisation are subject to regular audits and inspections.

1.17.2.2 Technical Communication 02.020-30

Technical communications (TC) contain announcements from the Federal Office of Civil Aviation regarding issues of airworthiness. These concern development, certification, manufacture and maintenance of aircraft/aircraft parts as well as of maintenance personnel and companies. . TCs usually consist of explanations or information on how the FOCA interprets certain legal provisions or which procedures it envisaged for their implementation..

On 20 October 2008, the FOCA published Technical Communication 02.020-30 relating to the binding nature of the operating times published by manufacturers for engines and propellers. The following, among other things, was published in this TC [translated from German]:

"1. General

(…)

1.1 Principle

The operating times (TBO) published by manufacturers for engines and propellers, as well as for components of engines and propellers are in principle binding for all aircraft, unless other provisions of higher law are applicable, or this Technical Communication provides an exception.

2. Definition

2.1 Life limits or certification-related operating time limits (Airworthiness Limitations)

These are set by the certificating authority of the country of the manufacturer in the equipment data sheets (Type Certificate Data Sheet, Fiche de Navigabilité, etc.) as well as in the maintenance and operating records of aircraft and are mandatory. Exceeding them means the loss of airworthiness.

2.2 Operating time recommendations (Recommended Time Between Overhaul TBO, Recommended Replacement and Overhaul Schedules, etc.)

Generally, these operating time recommendations constitute the limits within which correct functioning of engines and propellers, as well as components of engines and propellers, can be expected subject to compliance with specific provisions. They are designed to prevent the aircraft losing its airworthiness as a result of wearing or failure of essential components.

Normally they are recommended by the manufacturer under the following conditions:

• Specified maintenance in accordance with the maintenance documentation

• Average (normal) operational conditions. In the presence of special operational conditions (contact with salt water, aerotowing, climatic extremes, poor maintenance, etc.), however, the recommended tasks may become necessary before the manufacturer's recommendation

• Compliance with the operating instructions recommended by the manufacturer (service bulletins, etc.).

3. Application of manufactures' recommendations according to para. 2.2 for aircraft registered in the Swiss register of aircraft

3.1 Aircraft certified for commercial flights

The application of the manufacturer's recommendations must be regulated in the operator's documentation, i.e.:

• for operators with an AOC in the "Maintenance Program" approved according to JAR-OPS and EASA Part M

• for operators under VBR-1, the operating time limits recommended by the manufacturer (TBO) and, where appropriate, the requirements defined in an approved Maintenance Program apply

3.2 Aircraft used for training, sightseeing flights, charter and IFR flights

For aircraft used for sightseeing flights and training, which are certified according to the rules for instrument flight or which are chartered out, the operating times (TBO) recommended by the manufacturer for engines, propellers and components of engines and propellers are also mandatory.

Excluded from this are calendar operating time limits for engines and propellers.

(…)

3.1 Aircraft certified for non-commercial flights

The application of the recommended operating times is not mandatory for aircraft up to a maximum take-off mass of up to 5700 kg and with a certificate for non-commercial (private) use.

(…).

The FOCA considers compliance with the operating times a recommendation, but it is the responsibility of the operator of an aircraft to apply such manufacturer's recommendations, taking into account the current condition and the specific conditions of use in individual cases. Depending on the result of the technical assessment carried out in each case, he must decide either to comply with the recommended operating times or if an operating time needs be to shortened or extended.

This means that the operator, when taking his decisions, must take into account the technical assessment by a qualified maintenance company or appropriate maintenance personnel. The technical assessment must include the previous and future planned use of the aircraft, the maintenance records and the operating times of individual parts, components and of the entire aircraft.

(…)

3.4 Tolerances

(…)

3.5 Aircraft which are registered in the Swiss register

For all aircraft which are to be registered in the Swiss aircraft register for the first time, the operating times recommended by the manufacturer are also deemed to be mandatory. The operator must ensure that all engines, propellers and components of engines and propellers of the aircraft at the time of its import and registration, respectively are within the operating times (TBO) published by the manufacturer. Deviations from this may be allowed only in exceptional and justified cases and with the approval of the FOCA.

4. Fundamentals concerning the responsibility of the operator

According to Article 23 of the Ordinance on the Airworthiness of Aircraft, the operator is responsible for maintaining the airworthiness of his aircraft. He must ensure that the aircraft remains reliable in operation and that no danger is posed by its condition."

1.18 Additional information

1.18.1 Flight performance calculation for take-off and initial climb

It is notable that the ground temperature was 30 °C on the day of the accident (ISA + 22 °C). The resulting density altitude was approximately 5800 ft.

According to the aircraft manual, the manufacturer recommends setting the flaps to the position 0° or 25° for take-off. Taking into account take-off mass and density altitude, the following performance values result for the take-off and the initial climb in Saanen:

Flaps 25°	Take-off roll:	1100 ft (335 m)
	Take-off distance to 50 ft AGL:	1950 ft (594 m)
Flaps 0°	Take-off roll:	1500 ft (457 m)
	Take-off distance to 50 ft AGL:	2500 ft (762 m)

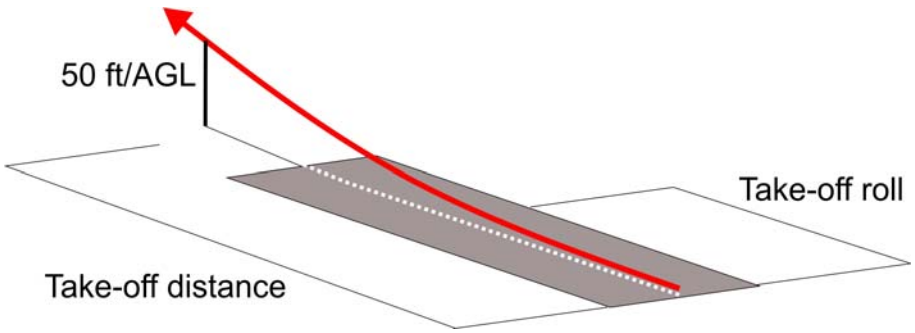

Figure 7: Schematic representation of take-off distance

2 Analysis

2.1 Technical aspects

There is no evidence of any pre-existing technical defects which might have caused or influenced the accident, apart from the damage in the engine.

The corrosion and wear damage to the camshaft and the tappet bodies found in the engine had the effect that on the day of the accident the engine was characterised by a distinctive loss of power of at least 15 to 20%. In addition, leaks in several valves led to a loss of compression in the corresponding cylinders.

The engine manufacturer recognised as early as the 1960s that corrosion damage may occur to its engines, especially if the aircraft is rarely used or is used in special climatic conditions. It had published several technical publications on this topic. The manufacturer therefore recommended in service instruction SI 1009AU that the engine should be overhauled every 2000 hours or every twelve years and in mandatory service bulletin 480E, that the engine oil and oil filter should be changed every 50 hours of operation or every four months, respectively. In addition the manufacturer recommended in service letter No. 180B that the engine should be operated for at least one hour in cruise flight every 30 days.

By means of technical message TM 02.020-30 the FOCA considers the application of the operating times recommended by the manufacturer up to a maximum take-off mass of 5700 kg for private operation, i.e. non-commercial use, as non-mandatory and delegates the responsibility to the operator. It is obvious that a distinction between commercial and private operation does not make sense from a technical point of view. Furthermore, it is surprising that mandatory service bulletin 480E was not declared to be an airworthiness directive - AD by the authorities of the country of manufacture.

On closer inspection it is clear that the engine, built in the year 1976, was operated for an average of more than forty hours per year in the first twenty years. This annual average decreased even further over the next few years to the effect that this engine had logged only 1256:34 operating hours at the time of the accident, i.e. after 34 years,. Thus the engine of HB-PRE was precisely within the above-mentioned range of application.

The worn components are situated inside the engine. Therefore, the corrosion and wear damage which was found is visible only in disassembled condition. Furthermore, measurement of cylinder compression does not permit any conclusion concerning the condition of the camshaft. An explicit assessment of the camshaft and the tappet bodies is only foreseen on the occasion of an engine overhaul. There is no evidence in the available technical records that the engine of the PA-32R-300 involved in the accident had undergone an overhaul since it was brought into service. The SAIB is of the opinion that consistent implementation of the manufacturer's recommendations would have prevented the damage to the engine and ultimately would very probably have prevented the accident.

In particular, the implementation of SI 1009AU would have meant that the engine of the aircraft involved in the accident would have been overhauled in the years 1988 and 2000. In these years, however, the aircraft was still abroad. However, at the latest after the import of this aircraft into Switzerland, all parties directly involved and dealing with the airworthiness of this aircraft, should have discussed the implementation of SI 1009AU. There was no evidence identified from the operator, the maintenance company, the CAMO, and the FOCA leading to the conclusion that such a discussion took place.

This topic would basically have been irrelevant if the corresponding recommendations of the engine manufacturer had been fully integrated into the maintenance program for this engine, regardless of whether the aircraft was operated commercially or privately.

2.2 Human and operational aspects

2.2.1 Crew

The pilot of HB-PRE was an experienced airline pilot. The aircraft involved in the accident was in his company only for just over a year. In the first year of operation, the pilot gained only little flying experience on this aircraft. This could explain why he did not notice the subtle degradation of engine performance over time.

The take-off roll for a take-off from Saanen with the flaps in the position 25° would normally have been 1100 feet (335 m) and the total take-off distance until 50 ft AGL was reached would have been 1950 ft (594 m). The actual take-off roll for the accident-flight was just about 800 m until the plane lifted off. It is impossible to judge whether the pilot noticed the misfirings during the run-up and during the take-off roll. It may be assumed that a pilot with great experience on the type PA-32-300R would have realised during the take-off roll that something might be wrong. In this case, it would have been possible to reject the take-off after about 800 m. Therefore it can be assumed that the pilot of HB-PRE had not defined any criteria for a rejected take-off.

The aircraft barely gained any height and cleared the obstacles beyond runway 26 only at low altitude. At this point, however, no other options remained, because no suitable emergency landing site was available as a result of the topographical conditions. This meant that the accident could no longer be prevented and ended tragically for all occupants.

Since the departure time from Saanen and the departure time of the scheduled flight from Zurich were just two hours apart and given the flight time to Zurich of approximately 40 minutes, a certain degree of time pressure cannot be excluded.

2.2.2 The pilot in his function as operator

Bodanair AG was a small aircraft operator in the process of being built up. On technical issues, the pilot was the single decision-maker. It is known that he called on the advice of experts on the technical side. However, the extent to which he was aware that the engine in HB-PRE might have degraded over time in view of its pre-history cannot be determined. Consequently this damage to the engine could reach such an extent that such a distinctive reduction in power occurred on the day of the accident.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The investigation revealed evidence of pre-existing technical defects which contributed to the accident.
- The PA-32R-300 was flown into Switzerland on 14 July 2009 as D-EHKM.
- D-EHKM had an ARC issued by the German Federal Aviation Office which was valid till 19 September 2009.
- This aircraft was registered on 18 August 2009 in the Swiss aircraft register as HB-PRE.
- In the period between 19 October and 13 November 2009, a full airworthiness review and a 100-hour airframe inspection and a 400-hour engine inspection at 1253:25 hours were attested.
- On 20 November 2009, the airworthiness certificate for HB-PRE was issued and the aircraft was therefore certified for VFR flights.
- HB-PRE and its engine were 34 years old and had logged 1256:34 operating hours at the time of the accident.
- Both the mass and centre of gravity of the aircraft were within the permitted limits according to the AFM at the time of the accident.
- The Lycoming mandatory SB 480E: Oil and filter change and screen cleaning, with due dates in March and July 2010 were not carried out.
- Various types of damage due to corrosion and wear were found inside the engine.
- Specifically the cam on the camshaft and the tappet bodies of the inlet valves of cylinders 5 and 6 were affected.
- The resulting loss of engine power was at least 15 to 20%.
- No emergency radio transmitter (ELBA) was fitted in HB-PRE.

3.1.2 Crew

- The pilot was in possession of the necessary licences for the flight.
- There are no indications of the pilot suffering any health problems during the accident-flight .
- The pilot flew a total of 5:46 hours on the type PA-32-300R and in the process completed 9 landings.

3.1.3 History of the flight

- Saanen aerodrome is situated at 3307 ft AMSL.
- The outside air temperature was approx. 30 ° C, with a light wind.
- A calculation after the event indicated that with the flaps in the position 25°, the take-off roll would normally have been 1100 feet (335 m) and the take-off distance until 50 ft AGL was reached would have been 1950 ft (594 m).
- The take-off roll of the accident-flight was approximately 800 m and the obstacles just 40 ft high beyond the end of the 1400 m long runway 26 were cleared by approximately 5-10 ft.

- The aircraft barely gained height and crashed into a pile of driftwood immediately next to the septic tanks of the Saanen waste water treatment plant, outside the aerodrome. Fire broke out shortly after the impact.
- The aircraft burnt out and it was not possible to rescue the occupants from the flames.

3.1.4 General conditions

- The engine manufacturer had been referring to possible corrosion in the engine since the 1960s and issued appropriate technical publications.
- The engine manufacturer recommended an overhaul of the engine every 2000 operating hours or every twelve years.
- The FOCA considered the application of the recommended operating times for private operation, i.e. non-commercial use, to be non-mandatory and delegated the responsibility to the operator.
- There is no evidence in the technical records that the engine of the PA-32R-300 involved in the accident had undergone an overhaul since it was brought to service.

3.2 Causes

The accident is attributable to the fact that shortly after take-off a collision with the terrain occurred because the aircraft was unable to gain sufficient height because of significantly reduced engine power. The loss of engine power can be explained by corrosion and wear damage to the camshaft and the tappet bodies.

The following factors contributed to the accident:

- Continuation of the take-off despite reduced engine power.
- Non-compliance with the recommendations of the manufacturer concerning the known corrosion problems in the engine.
- Non-integration of the corresponding recommendations of the manufacturer in the maintenance program of the engine.

4 Safety recommendations and measures taken since the accident

In accordance with Annex 13 of the ICAO, all safety recommendations listed in this report are addressed to the supervisory authority of the competent State, which must decide on the extent to which these recommendations are to be implemented. However, every agency, undertaking and individual is invited to attempt to improve aviation safety in the sense of the issued safety recommendations.

In the Ordinance on the Investigation of Air Accidents and Serious Incidents, Swiss legislation provides for the following regulation:

"Art. 32 Safety recommendations

[1] DETEC shall address implementation assignments or recommendations to FOCA, based on the safety recommendations in the reports from SAIB or on the foreign reports.

[2] FOCA shall inform DETEC regularly about the implementation of the assignments or recommendations.

[3] DETEC shall inform the SAIB at least twice a year about the progress made by FOCA with implementation."

4.1 Safety recommendations

4.1.1 Mandatory nature of manufacturer's recommendations

4.1.1.1 Safety deficit

On 26 August 2010, a PA-32R-300 aircraft, registration HB-PRE, took off on a private flight with two passengers from Saanen (LSGK) to Zurich (LSZH). Unusual engine sounds were perceived during the take-off roll. With a take-off roll distance of approximately 800 m, HB-PRE took an excessively long time before it finally lifted off. The aircraft subsequently gained hardly any height and finally crashed into a pile of driftwood near the Saanen ARA (wastewater treatment plant). All the occupants were fatally injured and the aircraft was destroyed.

The investigation revealed that corrosion and wear damage to the camshaft and the tappet bodies resulted in a significant loss of engine power.

The engine manufacturer recognised as early as the 1960s that corrosion damage may occur to its engines, especially if the aircraft is rarely used or is subject to particular climatic conditions. It had published several technical publications on this topic.

By means of technical message TM 02.020-30 the Federal Office of Civil Aviation (FOCA) considers the application of the operating times recommended by the manufacturer for aircraft up to a max. take-off mass of 5700 kg for private operation, i.e. non-commercial use, as non-mandatory and delegates the responsibility to the operator. It is obvious that a distinction between commercial and private operation does not make sense from a technical viewpoint.

4.1.1.2 Safety recommendation no. 459

The FOCA and the competent foreign authorities should consider measures which ensure that recommendations of the manufacturers regarding operating hours and calendar-based due dates are integrated into the maintenance programmes that are approved by the authorities, regardless of whether aircraft are operated commercially or privately.

Payerne, 4 December 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, 10 January 2013