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Aircraft Accident Investigation Bureau AAIB

Final Report No. 2006 by the Aircraft Accident Investigation Bureau

concerning the accident

to the aircraft Beechcraft BE 35-C33A Debonair, registration HB-KCK

on 1 April 2004

Lake of Geneva, between Les Moulins de Rivaz and Cully,
municipality of Puidoux/VD

approximately 14 km east/south-east of Lausanne

Ursachen

Der Unfall ist auf eine Notwasserung des Luftfahrzeuges nach einem Motorausfall zurückzuführen, dessen Ursache nicht ermittelt werden konnte.

General information on this report

This report contains the AAIB's conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with article 3.1 of the 9th Edition, applicable since 1st November 2001, of the Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future 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 French language.

All times in this report, unless otherwise indicated, are indicated in the standard time applicable to the area of Switzerland (local time – LT), corresponding at the time of the accident to Central European Summer Time (CEST). The relationship between LT, CEST and coordinated universal time (UTC) is: $LT = CEST = UTC + 2 \text{ h}$.

For reasons of protection of privacy and simplicity, the masculine form is used in this report for all natural persons, regardless of their gender.

Final Report

Aircraft	Beechcraft BE 35-C33A Debonair	HB-KCK
Operator	Private	
Owner	Private	
Pilot	Swiss citizen, born 1954	
Licence	PPL(A), first issued by the FOCA on 02.11.1995	
Flying hours	Total	766:36 during the last 90 days 11:58
	on the type involved in the accident	156:44 during the last 90 days 11:58
Location	Lake of Geneva, between Les Moulins de Rivaz and Cully, municipality of Puidoux/VD	
Coordinates	549 010 / 147 250 1:25 000 map, sheet 1243 Lausanne WGS84: N 46° 28' 28.7" / E 006° 46' 29.0"	Elevation 374 m AMSL
Date and time	1 April 2004, at approximately 18:45 LT	
Type of use	Non-commercial daytime and night-time VFR	
Flight phase	Cruise	
Type of accident	Landing on water following engine stoppage	

Injuries to persons

Injuries	Crew members	Passengers	Total number of persons on board	Other persons
Fatal	---	---	---	---
Serious	---	---	---	---
Slight	---	---	---	---
None	1	2	3	---
Total	1	2	3	

Damage to the aircraft Fuselage, landing flaps, elevator, wingtip tanks, 20 hours immersion

Damage to third parties Minor pollution of the lake, mainly by hydrocarbons contained by a floating barrage.

1 Factual information

1.1 History of the flight

1.1.1 Introduction

The description of the history of the accident flight, as well as the events preceding it, is based on the statements of the pilot, the passengers and eye witnesses.

1.1.2 Pre-flight history

On 28 March 2004, the pilot filled the tanks of his aircraft HB-KCK and took off from Grenchen (LSZG) at 10:40 LT for Donaueschingen (EDTD) with 432 l of fuel on board. He set off again at 11:55 LT for Grenchen.

On the same day, he took off from Grenchen at approximately 14:55 LT for Lugano (LSZA), from which he departed at 16:05 LT for Grenchen.

The cumulative flying time throughout the day of 28 March 2004 was 2:30 hours. No other flight was made up to the flight involved in the accident.

On 1 April 2004, the pilot went to Grenchen aerodrome to make a pleasure flight with two work colleagues. He carried out the checks on aircraft HB-KCK. He topped up the engine with a litre of oil and checked the tanks visually. These contained approximately 250 l of fuel in total, of which 30 l was in each wingtip tank. The rest was distributed between the two main tanks in the wings.

Concerning the check of the fuel drains, the pilot made the following statement: *„Ich habe grosse drains, auch daran ist mir nichts aufgefallen.“*. Translation: I have big drains; I also did not observe anything there.

The pilot met the two passengers at about 17:15 LT and they boarded the aircraft at about 17:30 LT. Before starting the engine, the pilot selected the fuller of the two main tanks which was the left tank.

1.1.3 History of the flight

At 17:46 LT, the pilot took off with two passengers on board the HB-KCK and headed for the Bernese Oberland. At about 18:15 LT, after flying over the Lake Thun, Interlaken, the Schilthorn and Saanen, the pilot selected the right tank and began a descent towards the lake of Gruyères, then headed towards Lake Geneva. At Vevey, he turned in the direction of Lausanne.

At approximately 18:40 LT, when he had reached an altitude of 4000 ft AMSL, the pilot heard a whistling noise and the engine stopped suddenly. A strong smell of fuel filled the cabin. The pilot switched off the autopilot and steered to the shore of the lake. He switched on the auxiliary fuel pump and switched it off again, moved the mixture control to RICH, positioned the propeller pitch control to HI RPM and selected the left tank. The propeller continued to turn, but the engine did not restart.

The pilot then decided to land on water along the shore. He unlocked the door and extended the flaps. He chose not to lower the landing gear. He slowed down the aircraft, pitching the nose up as far as possible. HB-KCK touched the surface of the lake with its tail then sank into the water. Deceleration was considerable and an enormous spray of water was formed. The aircraft came to a standstill about twenty metres from the shore, between Les Moulins de Rivaz and Cully. The lake was calm and the water temperature was 7 °C. The occupants evacuated the cabin and swam to shore. None of them was injured.

After 3 to 4 minutes, the aircraft sank into Lake Geneva.

An angler who witnessed the accident immediately informed the Vaud cantonal police operations centre (CET).

1.1.4 Investigation

The investigation was opened by the Aircraft Accident Investigation Bureau on the same day, in collaboration with the Vaud cantonal police.

1.2 Personnel information

1.2.1 Pilot

The pilot was holder of a private pilot licence for aircraft PPL(A) and was licensed to operate SEP aircraft (single-engine piston). He also possessed the NIT (A) rating (night flight).

The pilot was holder of a class 2 medical certificate.

The pilot completed his training on the Beechcraft BE 35-C33A Debonair on 24.01.2002

1.2.2 Passengers

The two passengers had no flying qualifications or experience.

1.3 Aircraft information

Registration	HB-KCK
Aircraft type	Beechcraft BE 35-C33A Debonair
Characteristics	Single-engine, four seater, metal, low-wing, retractable landing gear with nosewheel
Manufacturer	Beech Aircraft Corporation
Serial number	CE 67
Year of construction	1966
Engine	Teledyne Continental TCM IO-520-BA
Propeller	McCauley 3A32C76
Emergency beacon	The aircraft was not equipped with an emergency locator beacon (ELBA)
Total hours	Airframe: 3101:58 hours Engine: 1539:39 hours (TSO) Propeller: 1493:22 hours (TSN) / 140:38 hours (TSO)
Maintenance	The aircraft had flown 57:34 hours since the last 100 hours check carried out on 18.02.2003. At the time the aircraft was imported and registered in Switzerland, the airframe had accumulated 2491 operating hours. According to the aircraft technical documentation, the last 2000 hours check was carried out at 2142 hours. According to the manufacture's maintenance program, the next inspection of the main fuel selector was due at 3087 hours \pm 60 hours.

Last periodic inspection by the FOCA	The last periodic inspection by the Federal Office for Civil Aviation (FOCA) was carried out on 27.03.2002 at 2983:57 hours.
Mass and centre of gravity	The maximum permitted take-off mass is 3300 lb or 1497 kg. The total mass at the time of the accident was approximately 1415 kg. The mass and centre of gravity were within the prescribed limits.
Airworthiness certificate	Issued on 15.08.1995 by the FOCA

1.4 Meteorological information

1.4.1 General

The information contained in sections 1.4.2 to 1.4.4 was supplied by MétéoSuisse.

1.4.2 General weather situation

„Zwischen einem Hoch über Osteuropa und einem Tief über dem Atlantik herrscht im Alpenraum eine mässige Südströmung. In dieser werden trockene und eher labile Luftmassen in die Schweiz geführt.“

Translation:

Between a high over Eastern Europe and a low over the Atlantic, there was a moderate southerly airflow in the area of the Alps. This fed dry and rather unstable air masses into Switzerland.

End of translation.

1.4.3 Weather situation at the location and time of the accident

The following information on local weather conditions at the time of the accident is based on a spatial and temporal interpolation of the observations made by several weather stations.

<i>Wolken</i>	<i>3-6/8, Basis ca. 8000 ft AMSL</i>
<i>Sicht</i>	<i>15 – 20 km</i>
<i>Wind</i>	<i>Nordostwind mit 5 kt, Spitzen bis 8 kt</i>
<i>Temperatur / Taupunkt</i>	<i>+ 18 °C / + 5 °C</i>
<i>Luftdruck</i>	<i>QNH 1008 hPa</i>
<i>Gefahren</i>	<i>Keine</i>
<i>Sonnenstand</i>	<i>Azimut 252°, Höhe 22°</i>

Translation:

Cloud	3-6/8, base approximately 8000 ft AMSL
Visibility	15 – 20 km
Wind	North-east 5 kt, gusting to 8 kt
Temperature / dew point	+ 18 °C / + 5 °C
Atmospheric pressure	QNH 1008 hPa

Hazards None
Position of the sun Azimuth 252°, elevation 22°
End of translation.

1.4.4 Geneva-Cointrin METAR messages throughout the period of the accident

LSGG GVA GENEVA 011750 23009KT 9999 SCT070 BKN120 16/04 Q1009 NOSIG
LSGG GVA GENEVA 011720 24009KT 200V020 9999 SCT070 BKN120 17/04
Q1009 NOSIG

LSGG GVA GENEVA 011650 24012KT 9999 SCT070 BKN120 18/04 Q1009 NOSIG
LSGG GVA GENEVA 011620 28004KT 210V030 9999 FEW050 SCT070 18/02
Q1008 NOSIG

1.5 Wreckage information

1.5.1 Inspection of the wreckage

The wreckage was lying on its back in Lake Geneva, at a depth of approximately 25 metres. It could be located by air bubbles which appeared on the surface of the water.

It was raised the day after the accident, in the late morning. Attached by the propeller, the aircraft was raised with the aid of a crane, and then transported by boat to the port of Ouchy in Lausanne.



Fig 1: Recovery of the wreckage on the day after the accident

The following findings were made during the inspection of the wreckage:

- The door was open.
- Position of the selectors in the cockpit:
 - Fuel selector: RH
 - Transfer pumps: LH: ON / RH: OFF
 - Power lever: IDLE
 - Mixture control: IDLE CUT-OFF
 - Propeller pitch control: HI RPM
 - Ignition selector: BOTH
 - Auxiliary fuel pump selector: OFF
 - Flap control: DOWN
 - Landing gear control: UP
- Values read off from the indicators:
 - Altimeter setting: 1007 mb
 - Variometer: + 1000 ft/min
 - Engine hours counter: 1208.92 hoursThe other indicators showed normal values.
- The three point safety belts withstood the forces.
- The deformation of the propeller blades indicates that the propeller was turning and that the engine was not providing power at the moment of impact.
- One exhaust silencer was torn off on impact and was not found.
- The main drain located below the filter of the fuel selector valve was in the open position.
- The content of the fuel tanks was collected:
 - The left main tank contained approximately 60 l of fuel (AVGAS 100LL) and 2 l of water.
 - The right main tank was empty.
 - The 2 wingtip tanks were damaged on impact and the fuel leaked into the lake.

1.5.2 Investigation into the cause of the engine stoppage

On 5 April 2004, the wreckage was transported to the workshop commissioned to analyse the cause of the engine stoppage.

In its report, this commissioned company specifies:

(...)

Investigation effectuée en atelier:

Nous avons mis le système d'essence (partie haute pression) sous pression. Nous n'avons pas trouvé de fuite qui pourrait influencer le bon fonctionnement du moteur. Les quelques petites fuites découvertes sur le système d'injection sont dues à une corrosion suite à l'immersion de l'avion. Nous avons effectué un diagnostic du moteur et de ses composants ainsi que de l'échappement. Nous n'avons rien trouvé qui pourrait influencer son bon fonctionnement. Suite à l'immersion de l'avion, il s'est produit une corrosion des parties métalliques du moteur (cylindres, vilebrequin...). Le moteur s'est rapidement bloqué, ce qui ne nous a pas permis de mettre le moteur au banc d'essai. Les magnetos et les bougies ont été testées au banc d'essai et fonctionnaient correctement. La

pompe à essence électrique et la pompe à essence mécanique n'ont pas pu être testées suite à la corrosion des parties métalliques. Le démontage des pompes et l'inspection des différents éléments nous ont révélé qu'elles devaient fonctionner correctement. Suite à la découverte de la purge principale ouverte, nous avons effectué un test de résistance d'ouverture. Il faut une force de 1.8 kg pour soulever la purge et jusqu'à 3.5 kg pour la verrouiller [note du BEAA: en position ouverte].

Conclusion

Nous n'avons pas constaté d'autre anomalie que la purge principale sur la position ouverte, ce qui provoque une perte d'essence.

(...)

Translation:

(...)

Investigation carried out in the workshop:

We pressurised the fuel system (the high pressure section). We did not find any leak which might have affected the correct functioning of the engine. The few minor leaks discovered in the injection system are due to corrosion following immersion of the aircraft. We carried out diagnostics of the engine and its components, as well as the exhaust. We did not find anything which might affect correct operation. Following the aircraft's immersion, corrosion of the metallic engine parts (cylinders, crankshaft...) took place. The engine jammed quickly, so we were unable to put the engine on the test bench. The magnetos and spark plugs were tested on the test bench and operated normally. The electric fuel pump and the mechanical fuel pump could not be tested due to corrosion of the metal parts. Dismantling the pumps and inspection of the various elements revealed that they should have functioned correctly. Following the finding that the main drain was open, we carried out an opening resistance test. A force of 1.8 kg is necessary to lift the drain and up to 3.5 kg to lock it [note by the AAIB: in the open position].

Conclusion

We noted no anomaly other than that the main drain was in the open position, which causes a loss of fuel.

(...)

End of translation.

1.6 Medical and pathological information

The pilot and passengers received care for slight hypothermia from the ambulance medics. They did not suffer any injury.

The physical condition of the pilot was checked. No trace of alcohol was detected.

1.7 Fire

Fire did not break out.

1.8 Additional information

1.8.1 Evaluation of the loss of fuel through the main drain

When the wreckage was examined, the main drain was found in the open position. This is why a measurement of fuel loss was carried out on ground on an aircraft of the same type in order to assess the quantity of fuel which might have leaked out through the main drain if it had been in the open position throughout the accident flight.

Five different configurations were measured on the ground:

Configuration	Engine consumption	Fuel lost
Engine shut down	- - -	0.68 litre/min
Engine start-up sequence	- - -	0.22 litre
Idling	4 USG/hour	0.67 litre/min
Climbing power (2700 RPM)	21 USG/hour	0.41 litre/min
Cruising power (65%)	13.3 USG/hour	0.53 litre/min

Findings:

- When the fuel selector is OFF, only the quantity of fuel in the selector filter flows out from the main drain.
- Engine operation is not affected at all by the opening of the main drain or by selection of the tank when the drain is open.
- The loss of fuel through the main drain decreases when the fuel flow to the engine increases.
- A strong smell of fuel occurs in the cabin immediately after the opening of the main drain, with the inspection hatch closed.

On the basis of the measurements which were taken, it is possible to evaluate the quantity of fuel which would have been lost during the accident flight if the main drain had remained opened after the check carried out before departure. The quantity of fuel lost can be estimated at between 28 l and 35 l.



Fig 2: Main drain located under the floor of the cabin.



Fig 3: Fuel leakage from the main drain with engine shut down

1.8.2 Calculation of the quantity of fuel at the time of the accident

According to the pilot's statement, the fuel quantity on board was approximately 250 litres before departure from Grenchen.

Calculating the fuel consumption for all the flights made since the last refuelling of the aircraft enables us to obtain the following results:

- Fuel on board on departure from Grenchen: approximately 250 l.
- Fuel on board at the time of the accident: approximately 180 l.
- Fuel on board at the time of the accident with the main drain open: approximately 150 l.

1.8.3 Engine air start procedure

In the aircraft flight manual, the air start procedure is described as follows (*Section III – Emergency procedures – page 3-5: AIR START PROCEDURE*):

1. *Fuel Selector Valve – SELECT TANK MORE NEARLY FULL (check to feel detent)*
2. *Throttle – RETARD*
3. *Mixture – FULL RICH*
4. *Auxiliary Fuel Pump – ON until power is regained, then OFF.
(Leave ON if engine driven fuel pump is inoperative.)*
5. *Throttle – ADVANCE to desired power*
6. *Mixture – LEAN as required*

According to the pilot's statement, he tried to restart the engine as follows:

„(...) Der Propeller drehte hundertprozentig sauber. (...). Dann habe ich angefangen alles zu kontrollieren und habe die fuel pumpe ein- und wieder ausgeschaltet.

Der Mixer war auf rich, der prop auf high eingestellt. Dann habe ich den Tank wieder auf links geschaltet. (...)

Translation:

(...) The propeller was rotating normally. (...). Then, I started to check everything; I switched on the fuel pump and switched it off again.

The mixture was set on rich, the propeller on high. Then I switched to the left fuel tank again. (...)

End of translation.

1.8.4 Accident to an aircraft of a similar type

In 1980, a Beechcraft BE 35-F33A Bonanza crashed just after taking off when it attempted an emergency landing following a sudden engine stoppage (refer to investigation report no. 1980/24 1018).

This aircraft was fitted with the same fuel selector, and therefore the same main drain, as that on HB-KCK.

The investigation report mentioned in particular:

- That on the basis of the traces:
 - the main drain was in the open position at the time the fire broke out during the accident,
 - it is unlikely that the drain opened as a consequence of the impact.

- That during the tests on the ground with the main drain open, the engine operated normally on start-up and at take-off power.
- That the cause of the engine stoppage was unknown.

The preliminary investigation report also notes:

- That the shape of the bayonet which is fitted to the drain in question requires a rotary movement to open it, and to maintain it in the open position
- That during the external check on the aircraft, with the fuel selector closed, the drain might accidentally have stayed in the open position.

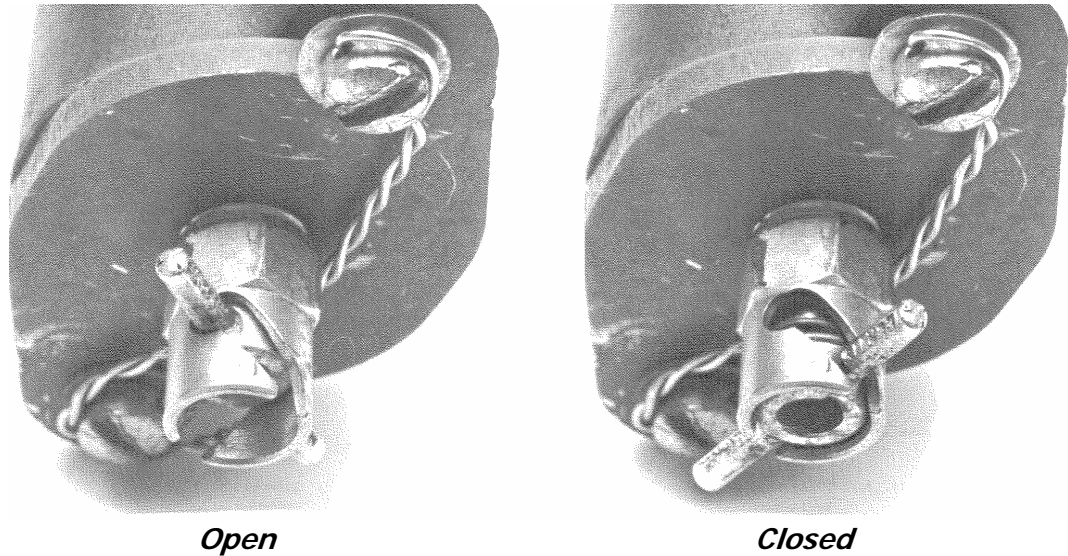


Fig 4: Main drain opening and closing system

2 Analysis

2.1 Technical aspects

The inspection of the wreckage and the investigations carried out on the engine and its fittings did not permit to determine the origin of the engine stoppage.

The tests carried out on the ground on an identical aircraft showed that performance was not affected when the main drain was open. Moreover, the conclusions of the investigation report on the accident involving a similar aircraft in which the main drain was found in the open position also mention that the engine functioned normally when the main drain was open.

In addition, for safety reasons, the loss of fuel could not be determined with the main drain open in flight. Furthermore, this drain, located below the fuselage between the two wings, may have opened during impact on the lake.

Taking the elements provided by the pilot into account, namely:

- Take-off from Grenchen on 28 March 2004 with 432 l of fuel on board
- Followed by 2:30 hours of flight
- Take-off on 1 April 2004 with 250 l of fuel on board, i.e. 2 x 30 l in the wingtip tanks
- Flight time of approximately 30 min on the left tank, then changeover to the right tank
- Stoppage of the engine after approximately 10 min flight time on this tank
- Strong smell of fuel inside the cabin
- Switching on and off of the auxiliary fuel pump
- Selection of the left tank during the attempt to restart the engine

and the results of the experts' technical report in collaboration with the manufacturer, the AAIB is unable to explain the origin of the engine stoppage.

The pilot has attempted to restart the engine, without success. Supposing that the engine stoppage originated from fuel starvation and the mechanically driven pump was functioning correctly, it is important to note that restarting a hot injection engine is relatively difficult. First it's a matter of restoring the fuel pressure required to restart the engine. However, excessive pressure may result in a too rich air/fuel mixture and in fact prevents any restart. One speaks of a flooded engine. In this case, the excessive fuel drains under the fuselage and provokes a smell.

In the present case, it is not possible to establish the reason why the engine did not restart. However, the smell of fuel noticed by the occupants may originate from an excessive fuel pressure during the attempt to restart.

2.2 Operational and human aspects

2.2.1 Engine air start procedure

According to the pilot's statements, the engine stoppage occurred when the aircraft was at an altitude of approximately 4000 ft AMSL over Lake Geneva, heading towards Lausanne.

The pilot tried to restart the engine in a way which differs from the procedure prescribed by the manufacturer in section III of the flight manual (refer to chap. 1.8.3). In fact, the misuse of the auxiliary fuel pump may have prevented the engine restart. However, it is not possible to assert that the use of the procedure prescribed by the manufacturer would have allowed restarting the engine.

2.2.2 Emergency landing

The terrain of the lake's shore is uneven and covered with vineyards for a relatively large distance onto the land. Since the aircraft was too far away to reach an aerodrome by gliding, the solution of ditching seems appropriate.

The weather conditions were good and the lake was not rough. In order to minimise the risks to the occupants on impact with the water surface, the pilot did not lower the landing gear and strongly pitched up the aircraft. The flaps were extended and the door was unlocked. All these factors contributed to the successful ditching and allowed the occupants to reach land without injury, even though the water temperature was only 7 °C.

The flying technique adopted by the pilot during the ditching was adequate and enabled the aircraft to be kept under control until impact.

3 Conclusions

3.1 Findings

- The pilot was in possession of an appropriate licence.
- The medical examination took place on 16.06.2003. The class 2 certificate did not mention any restriction.
- The prescribed limits for mass and centre of gravity were complied with.
- The aircraft was authorised for VFR day and night flying.
- The pilot did not make a distress call.
- The three point safety belts were fastened and withstood the impact.
- The aircraft was not equipped with an emergency locator beacon (ELBA).
- The aircraft remained on the surface of the water for a few minutes, allowing the occupants to evacuate the cabin and swim to the shore.
- At the time of the initial inspection of the wreckage, the fuel selector was positioned on the right tank (RH), the mixture control was on IDLE CUT-OFF and the main drain, located below the fuel selector, was in the open position.
- The left main tank contained approximately 60 l of fuel (AVGAS 100LL) and 2 l of water. The right main tank was empty. The two wingtip tanks were damaged on impact.
- The deformation of the propeller blades indicated that the propeller was rotating and that the engine was not supplying power at the time of impact.
- The wreckage was lying on its back in Lake Geneva, at a depth of approximately 25 metres.
- Following the finding that the main drain was open, an opening resistance test was carried out. A force of 1.8 kg is required to open the drain and 3.5 kg to lock it in the open position.
- The weather conditions did not influence the accident.

3.2 Causes

The accident is due to the aircraft making an emergency landing on water following an engine stoppage, the origin of which could not be determined.

Payerne, 16 December 2008

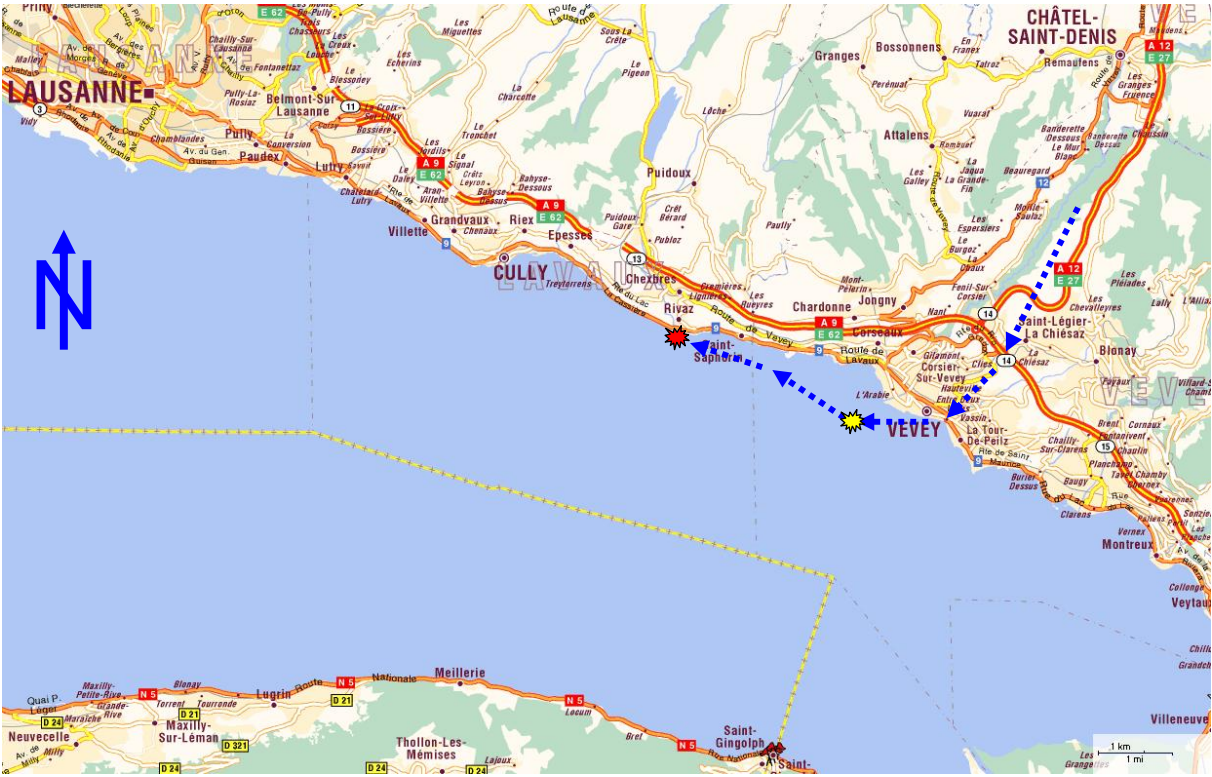
Aircraft Accident Investigation Bureau


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Annexe 1: Illustration of the HB-KCK final flight path



 Engine stoppage

 Landing on water