Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

Air Accident Investigation Unit
- (Belgium)
CCN
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FINAL REPORT ON THE ACCIDENT TO PIPER PA-28 REGISTERED OO-TMI AT EBZH ON 08 FEBRUARI 2011

Ref. AAIU-2011-01
Issue date: 08 April 2011
Status: FINAL

FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident.

In accordance with Annex 13 of the Convention on International Civil Aviation, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Art. 17.3 of EU Regulation 996/2010 stipulates that a safety recommendation shall in no case create a presumption of blame or liability for an accident, serious incident or incident.

Unless otherwise indicated, recommendations in this report are addressed to the Regulatory Authorities of the State having responsibility for the matters with which the recommendation is concerned. It is for those Authorities to decide what action is taken.

The investigation was conducted by L. Blendeman and H. Metillon.
The report was compiled by L. Blendeman

NOTE:
For the purpose of this report, time will be indicated in UTC, unless otherwise specified.

Synopsis

Date and hour of the accident

08 February 2011 at 10:00 UTC

Aircraft

Piper PA-28-161, msn 2842278, registered OO-TMI

Accident location

On EBZH airfield.

Aircraft owner

Ben Air Flight Academy

Type of flight

Pilot licence examination flight

Persons on board

2

Abstract

The student pilot was ready to pass the PPL skill test. The examination day was postponed due to bad weather, and after 15 days, he finally got an appointment.

After completing the flight preparation, the airplane took-off from EBAW at 09.20 UTC. The airplane went east towards Tessenderlo for the various flight examination exercises, then on towards Liege (Romeo entry point).
The flight plan included a landing at the EBZH airfield. The pilot applied the procedure for landing at this airfield.

They were flying at 1550ft agl, overhead EBZH, when the Flight examinator initiated a simulation of a Practiced Forced Landing (PFL).

During final approach, the pilot noticed he was too low, and decided to abort the landing. When applying gently more throttle, the engine did not respond, and stayed at low rpm.
The Flight examinator took over in an attempt to reach the airfield.

The airplane touched down in the field in front of the airfield, crossed a road, and came to a stop, after hitting concrete pillars and barbed wires.
The two occupants climbed out of the airplane, uninjured, after having shut down all power, switches and controls.

1. Factual information.

1.1 History of flight.

The student pilot had to pass the PPL skill test. The examination day was postponed due to bad weather, and after 15 days, he finally got an appointment.

He arrived at the BAFA Flight school at 07.20 UTC, and started the preparation for the flight. After being satisfied with the flight preparation, he went to the Flight examinator for the briefing. They went to the hangar to get the airplane out, performing the pre-flight, including the drain of the tanks, verification of engine oil, etc.

They taxied to the fuelling station, and filled both tanks full (there were 35 US Gallons remaining in the fuel tanks).

The take-off from EBAW was at 09.20 UTC. They flew towards Tessenderlo for the various flight examination exercises, then on towards Liege (Romeo entry point).

The carburetor heater system was briefly put ON at the beginning of the flight, and remained OFF for the rest of the flight.

The flight plan included a landing at the EBZH airfield. The pilot applied the procedure for landing, including the fuel tank switching and activating the fuel pump.

They were flying at 1550ft agl, overhead EBZH, when the Flight Examinator initiated a simulation of a Practiced Forced Landing (PFL).

The Flight Examinator stated he sequentially retarded the throttle to idle, and set the carburator heater ON. The pilot put the airplane in descend, for an approach on Runway 27 at EBZH. The pilot applied the emergency landing procedure (73kts, 10° flaps) and adjusted the stabilizer trim. Further, turning for base leg, he selected flaps 2 (25°).

During the descend, the turns were coordinated, and the pilot recalled watching the engine turning at least at a speed of 900rpm (around 900 – 1000 rpm). In final, the airspeed was around 65 kts.

Another aircraft was in final in front of OO-TMI, so the pilot extended the downwind for a few seconds.

During final approach, the pilot saw he was too low, and decided to abort the landing. When applying gently more throttle, the engine did not respond, and stayed at low rpm.

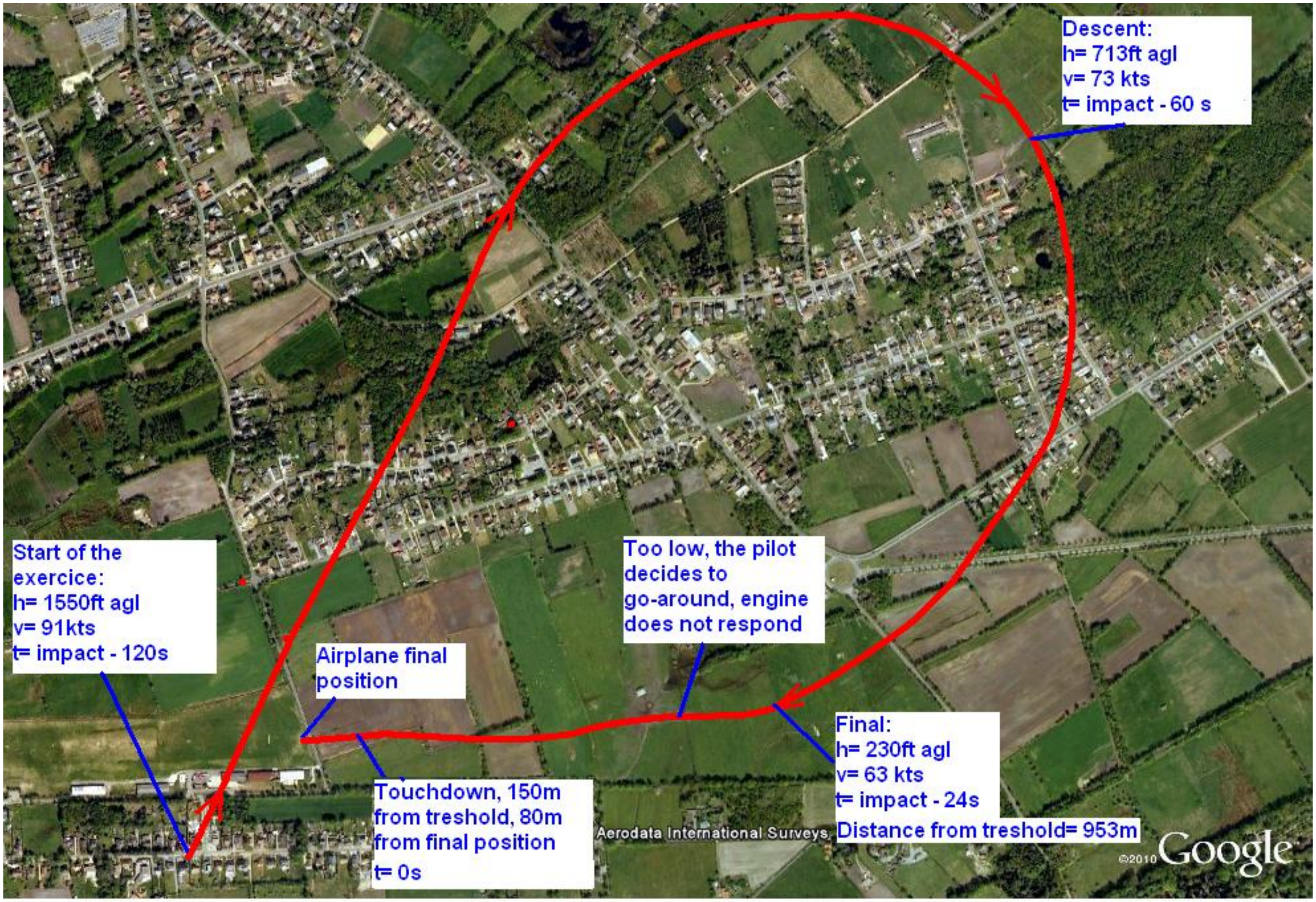
The Flight Examinator took over, lowered the nose to get more speed and to avoid stalling the airplane, in an attempt to reach the airfield.

The pilot stated he checked the instruments and the controls (rpm: around 900rpm, fuel tank selection, engine pump, throttle and mixture).
The pilot even tried to engage the starter, without success.

The airplane touched down in the field bordering the airfield, crossed a road, and came to a stop, after hitting concrete pillars and barbed wires.

The airplane stopped 80m from the initial touchdown point.

The two occupants climbed out of the airplane, uninjured, after having shut down all power, switches and controls


Descent:
h= 713ft agl
v= 73 kts
t= impact - 60 s
Start of the exercice:
h= 1550ft agl
v= 91kts
t= impact - 120s
Too low, the pilot decides to go-around, engine does not respond
Airplane final position
Final:
h= 230ft agl
v= 63 kts
t= impact - 24s
Distance from treshold= 953m
Touchdown, 150m from treshold, 80m from final position
t= 0s
Aerodata International Surveys
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1.2 Injuries persons.

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	2	0	0	2
Total	2	0	0	2

1.3 Damage to aircraft.

The airplane sustained heavy damages to ;

- The Nose Landing Gear (broken)
- The LH Main Landing Gear (broken)
- The propeller was bent (mostly on one blade)
- The fire wall was slightly bent
- Impact damage on both wings.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1. Student Pilot

Sex: male
Age: 22 years old
Nationality: Belgian
Student Pilot Licence, dated 02 MAR 2010, valid until 02 MAR 2015
Medical certificate: Class 1

1.5.2. Flight Examinator

Sex: male
Age: 53 years old
Nationality: Belgian
License:

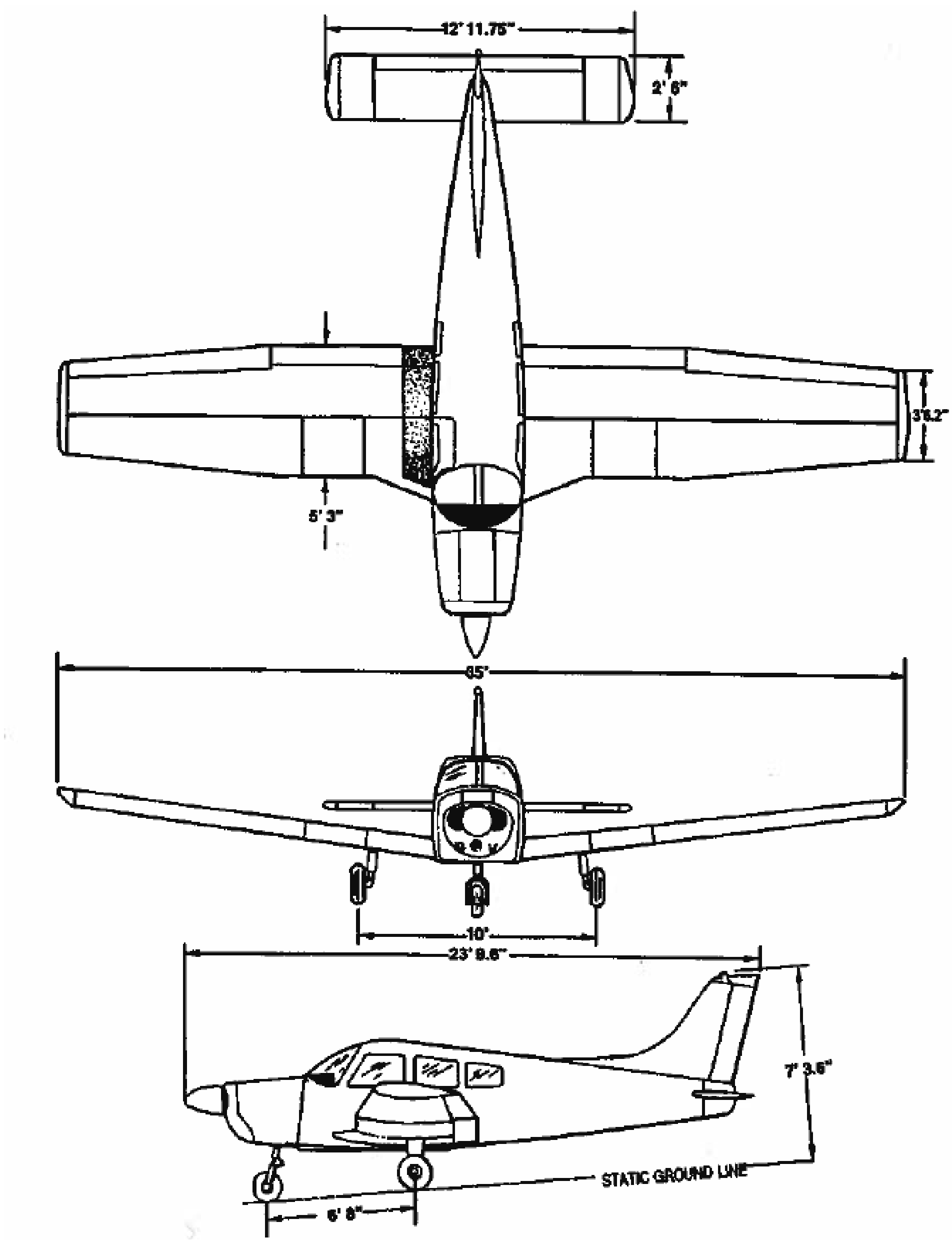
- Commercial Pilot Licence, first issued 03 DEC 1999, valid until 02 SEP 2013.
  Rating:
  - SEP(land), valid until 30 SEP 2011
  - MEP(land), valid until 31 AUG 2011
  - IR(A), valid until 31 OCT 2011
  - FI(A), IRI(A) valid until 30 NOV 2011
- Medical Certificate: Class 1, valid until 28 AUG 2011.
- Flight Examinator, issued 10 DEC 2008, valid until 31 DEC 2011.

Total Flight Experience: 9741:43 FH, including more than 6000 FH as a Flight Instructor

1.6 Aircraft information.

The Piper PA-28-161 Warrior III is a four places, low wing, fixed landing gear landplane, developed from the Piper PA 28 Cherokee. It is equipped with a Lycoming O-320-D3G engine of 160 hp (119 kW) and a fixed pitch propeller. The airplane type has a Maximum Take-Off weight of 2,440 lb (1,107 kg) (Normal Category).

It was first certificated on 1 July 1994 by the US FAA, and the Type Certificate N° 2A 13 was further validated by the EASA.



Airframe:

- Manufacturer: Piper Aircraft Inc.
- Type: PA-28-161
- Serial number: 2842278
- Built year: 2006
- Total Time: 3222.32 FH
- Registration: OO-TMI
- Certificate of registration: N°10114, issued by BCAA on 20 March 2007
- Certificate of airworthiness issued by BCAA on 21 March 2007.
- Airworthiness Review Certificate: issued by Vliegwerk Holland, Part M Subpart G – approved agency (ref. NL.MG.8156) on 30 March 2010, and valid until 30 March 2011.
- Certificate of Authorized Flights for Private Flights, First Flights and Training, issued by BCAA on 2 April 2010 and valid until 2 April 2011.

Engine:

- Manufacturer: Lycoming
- Model: O-320-D3G
- Engine TSO: 56.2 FH
- Engine TT: 4056.2 FH
- Serial number: L-766-39E

Propellers

- Manufacturer: Sensenich
- Model: 74DM6-0-60
- Total Time: 3218.9 FH
- Serial number: A61150

Owner:
Ben-Air Flight Academy.

Continuing Airworthiness:
The applicable maintenance program (ref: AMP/OO-TMI/ Revision 00) was approved by BCAA on 29 March 2010.
The last maintenance tasks performed on OO-TMI, as recorded, were:

- a 50 FH inspection performed on 31 January 2011.
- the carburetor heater control cable was adjusted on 12 January 2011.
- The engine, and accessories (hoses, muffler, starter, alternator, carburetor, carburetor heat box valve and both magneto's) were replaced on 2 November 2010. The replaced engine was certified "overhauled" by Lycoming Engines (FAA CFRS EJ1R115K – EASA.145.5704) on 5 August 2010.

The maintenance tasks were performed by Winters Aviation Part-145 Approved Maintenance Organisation ref BE.145.28.

Note:
The approved maintenance program still refers to the original engine installed on OO-TMI.
The ELT Artex 110-4 activation switch was placarded "ELT removed".

1.6.1. Flight Manual

The pilot was preparing the airplane for landing at EBZH, before the initiation of the exercise.

The flight Manual Section 4: Normal Procedures prescribes the following:

APPROACH AND LANDING

Fuel selector .... proper tank.
Seat Backs .... erect.
Belts/harness .... fasten/check
Electric fuel pump .... ON
Mixture .... set
Flaps .... set – 103 KIAS max
Trim to 70KIAS
Final approach speed (flaps 40°) .... 63 KIAS

Additional notes in 4.31 indicate

The mixture control should be kept in full RICH position to insure maximum acceleration if it should be necessary to open the throttle again. Carburetor heat should not be applied unless there is an indication of carburetor icing, since the use of carburetor heat causes a reduction in power which may be critical in case of a go-around. Full throttle operation with carburetor heat can cause detonation.

The Flight Examinator initiated the simulation of Practiced Forced Landing (PFL).

The Flight Manual Section 3: Emergency Procedures prescribes the following:

ENGINE POWER LOSS IN FLIGHT
Fuel selector .... switch to tank. containing fuel.
Electric Fuel Pump .... ON
Mixture .... RICH
Carburetor Heat .... ON
Engine Gauges .... check for indication of cause of power loss
(…)
If power is not restored, prepare for power off landing
Trim for 73 KIAS

POWER OFF LANDING
Locate suitable field.
Establish spiral pattern
1000 ft. above field at downwind position for normal landing approach. When field can easily be reached slow to 63 KIAS for shortest landing.

Touchdowns should normally be made at lowest possible airspeed with full flaps.

When committed to landing:
Ignition .... OFF
Battery Master Switch .... OFF
ALTR Switch .... OFF
Fuel selector .... OFF
Mixture .... idle cut-off
Seat Belts and harnesses .... tight.

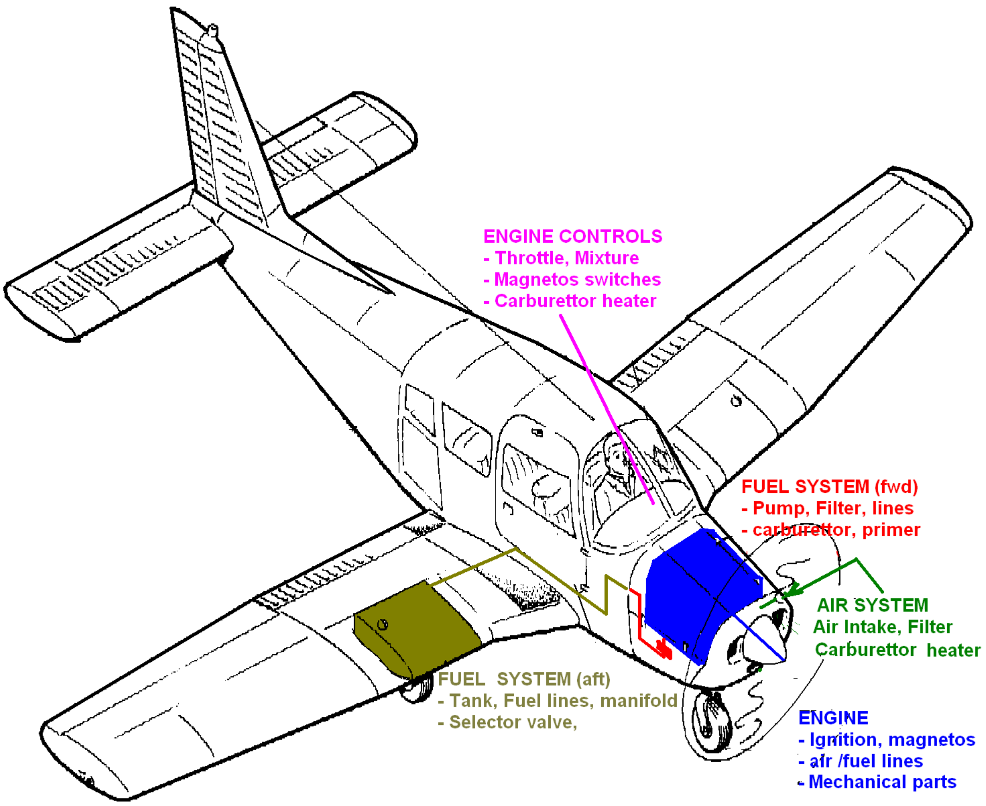
Note:
These actions were not all applied by the pilot upon landing, owing to the possibility of performing a go-around (BAFA has a training procedure for PFL – see Chapter 1.17. of this report). The pilot stated that, after the Flight Examinator took over, he checked the position of the controls, but did not change any. The Flight Examinator stated that when he took the controls, he concentrated on flying, and did not change any controls, at the exception of the flaps, which he stated he moved up.
Most of the shutting down procedure was taken immediately after impact.

1.6.2. Propulsion System.

The propulsion system of the Piper PA-28 is composed of:

- an engine, with mechanical parts driving a propeller and electrical system, providing energy (sparks) in the engine cylinders.
- a Fuel System, composed of various elements, including fuel tanks, lines, selector valves, pup, filter and a carburetor.
- An Air System, providing air for the combustion, including an air intake, filter and a carburetor heater.
- A controls system, with throttle, mixture controls, magneto switches and carburetor heater controls.

The failure of one or more of the above-mentioned elements (by wear, rupture, clogging, …. or eventually absence of fuel) may lead to the stopping of the engine. The inspection of these elements for condition would identify any of such failures.



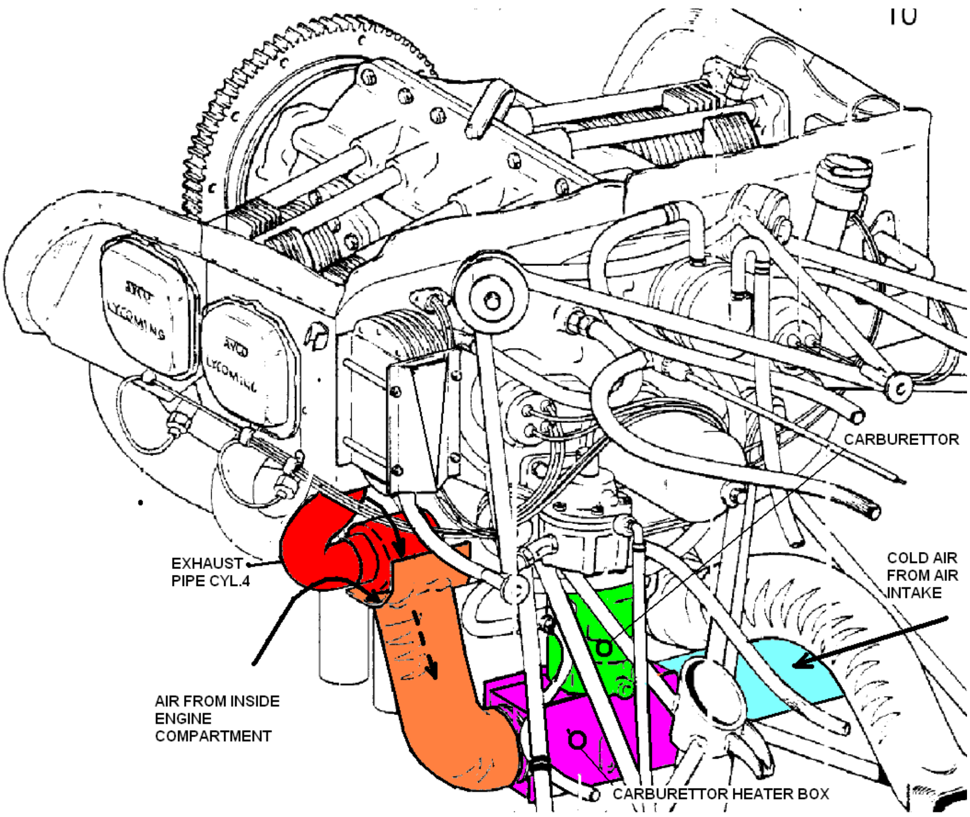
1.6.3. Carburetor Icing

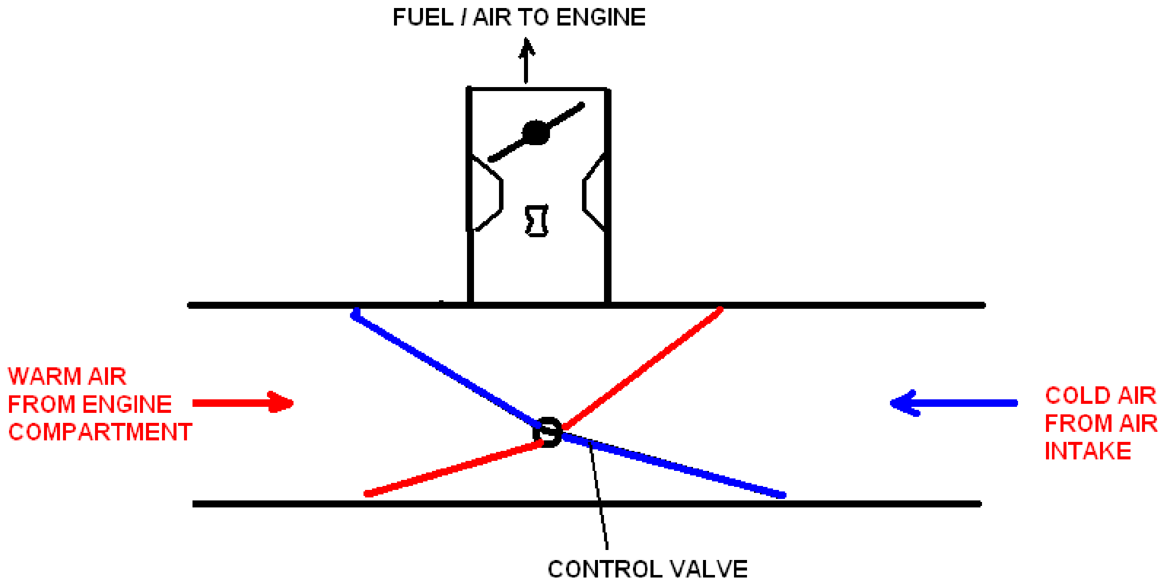
A particular engine failure mode is the carburetor icing, as the condition leading to the failure, as ice melts, disappears rapidly after the crash (another being the vapour lock, but the conditions necessary for this phenomenon were not met).

The Flight Manual states:

> ***3.29. CARBURETOR ICING***
>
> *Under certain moist atmospheric conditions at temperatures of -5°C to 20°C, it is possible for ice to form in the induction system, even in summer weather. This is due to the high air velocity through the carburetor venture and absorption of heat from this air by vaporization of the fuel.*
>
> *To avoid this, carburetor preheat is provided to replace the heat lost by vaporization. Carburetor heat should be full on when carburetor ice is encountered. Adjust mixture for maximum smoothness.*

The carburetor heater system consists of a box, connected to the carburetor casing, and further connected to the air intake, on one side, and to a scoop sucking air in the vicinity of the exhaust pipe of cylinder Nr 4.





The carburetor heat handle in the cockpit controls the position of the control valve in the carburetor heater box, through a cable system.

The Carburettor heater system is certified in accordance with CS23.1093:

CS 23.1093 Induction system icing protection
(a) *Reciprocating engines*. Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of -1°C (30°F) –
(1) Each aeroplane with sea-level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 50°C (90°F) with the engines at 75% of maximum continuous power;

Carburetor Ice Detector.

PA-28-161 are optionally equipped with a carburetor ice detection system. This system is an advisory system only and is designed to alert the pilot to impending engine power loss or stoppage due to ice/frost accumulation inside the carburetor.

This system is based upon an optical probe, activating a red warning light in the cockpit.

This system was not installed on OO-TMI.

1.7 Meteorological conditions.

The METARs, as recorded in Brussels and Liege.

METAR EBBR
METAR EBBR 080920Z 28004KT CAVOK 06/03 Q1024 NOSIG=
METAR EBBR 080950Z 30005KT 270V330 9999 FEW024 07/03 Q1024 NOSIG=
METAR EBBR 081020Z 30003KT 260V360 9999 FEW024 07/03 Q1025 NOSIG=
METAR EBBR 081050Z 28003KT 240V310 9999 FEW024 08/02 Q1025 NOSIG=

METAR EBLG
METAR EBLG 080920Z 30004KT 270V330 CAVOK 06/03 Q1024 NOSIG=
METAR EBLG 080950Z 26004KT CAVOK 06/02 Q1024 NOSIG=
METAR EBLG 081020Z 26003KT 220V320 9999 FEW014 07/02 Q1024 NOSIG=
METAR EBLG 081050Z VRB03KT 9999 FEW015 07/02 Q1024 NOSIG=

The conditions recorded at EBZH at the time of the accident would have been:

Wind:
Direction 270°
Speed: 5kts

Temperature: 7°C
Dew Point: 3°C

Visibililty: more than 10km

QNH: 1024hPa

1.8 Aids to navigation.

The airplane is equipped with the following avionics:
2 Garmin GNS 430 VHF Communication transceiver/VOR/ILS receiver/GPS receiver.
1 Bendix King KR-87 Digital ADF with KI-227 Indicator
1 S-TEC Model ST-531 Manual Electric Trim System
1 Garmin GTX 330 transponder

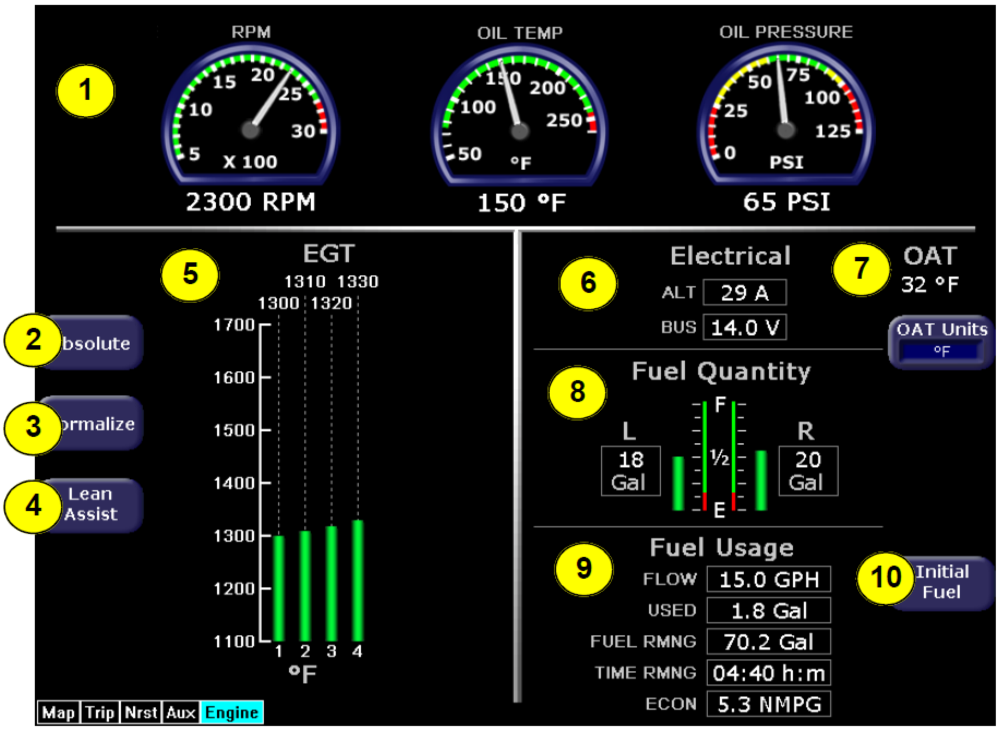
The airplane is also equipped with the Avidyne FlightMax Entegra EXP5000 series 700-00006-0xx-( ) Primary Flight Display (PFD) with 530-00138-000 software and a EX5000 series 700-00004-006 (sn 20093236) Multi-Function Display (MFD) with 530-00137-000 software and a Data Acquisition Unit (DAU – sn 172)

The PFD is intended to be the primary display of primary flight and essential engine parameter information to the pilot.

The MFD is intended to be a supplemental display of situational and navigation information to the pilot. Its primary function is to provide a moving map display to the pilot, along with other information. The unit is organized around logical groupings of information presented on "Pages".

Engine Page

The MFD provides the display of the following aircraft parameters:



1. **PA-28 Gauges**
   i. **RPM** – displays the current engine speed in revolutions per minutes.
   ii. **Oil Temp** – displays the current engine oil temperature in degrees Fahrenheit.
   iii. **Oil Pressure** – displays the current engine oil pressure in pounds per square inch (psi).

2, 3 and 4 EGT display modes
   i. **Absolute** indicates the current temperature for each cylinder.
   ii. **Normalize** indicates overall changes in temperature.
   iii. **Lean assist** allows to optimize the mixture for various operating conditions.

5. **EGT**
Indicates the exhaust gas temperature (EGT) of each cylinder in degrees Fahrenheit as a bar graph.

6. **Electrical gauges.**

ALT—Indicates the amount of current in Amps being produced by the alternator.
BUS—Indicates the bus voltage in volts.

7. **Outside Air Temperature (OAT)**
Indicates the ambient air temperature as reported by the Avidyne PFD. Press *OAT Units* to change the display between degrees Fahrenheit and degrees Celsius.

8. **Fuel Quantity and Fuel Flow:**
Fuel Quantity—
Shows the current fuel quantity as reported by the aircraft fuel tank sensors.

Flow—Displays the current fuel flow in gallons per hour as reported by the DAU.

9. **Fuel Usage, displays the following information:**

Used—Displays the total amount of fuel used since the last engine start as reported by the DAU.
Fuel Rmng—Displays the total amount of fuel remaining as calculated by the EX5000 based on the starting fuel you entered on the Initial Usable Fuel page and fuel flow as reported by the DAU.
Time Rmng—Displays the amount of time remaining before the total usable fuel on board will be consumed as calculated by the EX5000 based on the setting from the Initial Usable Fuel page and fuel flow as reported by the DAU. This value is only displayed when the GPS ground speed is greater than 50 knots.

Econ—Displays the current fuel economy in nautical miles per gallon based on the fuel flow as reported by the DAU and the groundspeed as reported by the GPS. This value is only displayed when the GPS ground speed is greater than 50 knots.

10. **Initial Fuel**
Opens the Initial Usable Fuel Page.

1.9 Communication.

Not relevant.

1.10 Aerodrome information.

EBZH, Kiewit airfield, called the 'oldest airfield in Belgium', is located 8km N of the city of Hasselt, Limburg.

The airfield is operated by day time only.

Address:
Aeroclub Kiewit
Luchtvaartstraat, 100 Bus 1
B - 3500 Hasselt

Coordinates: 50°58'12"N - 005°22'30"E

Elevation: 43m

Runway QFU: 090° / 270°

Runway dimensions: 600m x 18m

Surface : grass.

Runway strength : 5700kg

Procedures: RWY 27: right-hand circuit Circuit ALT 1 400 ft

1.11 Flight recorders.

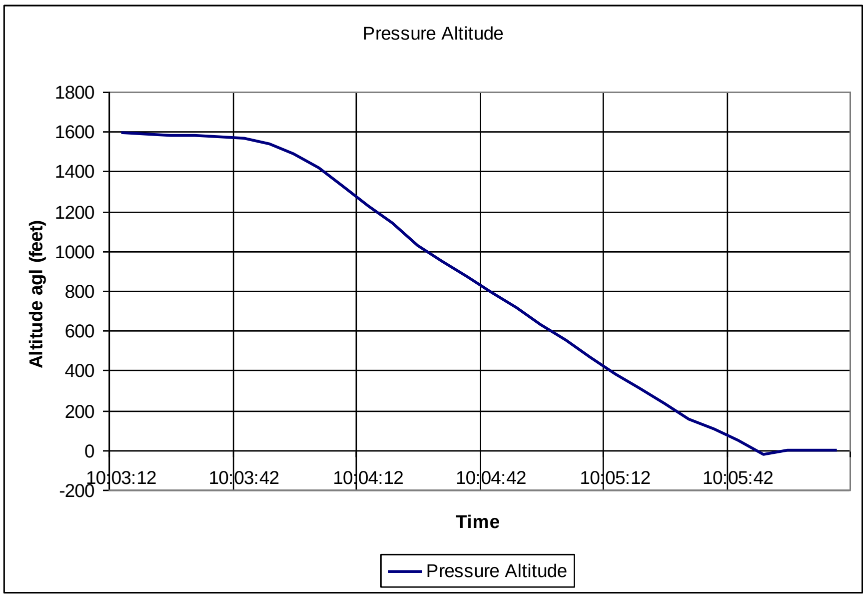
The Avidyne FlightMax Entegra EXP5000 PN 700-00004-006 (sn 20093236) Multi-Function Display (MFD) has a memory function that allows the following flight parameters to be recorded every 6 seconds.

- Time;
- Latitude
- Longitude
- Pressure Altitude
- EGT 1,2,3,4
- Oil Temperature
- Oil Pressure
- RPM
- OAT
- Fuel Flow
- Fuel Used
- AMPS
- Volts
- Fuel Quantity Left Tank
- Fuel Quantity Right Tank

The read-out of the parameters recorded in the EX5000 series 700-00004-006 (sn 20093236) Multi-Function Display (MFD) was performed by ASP-avionics in Genk.

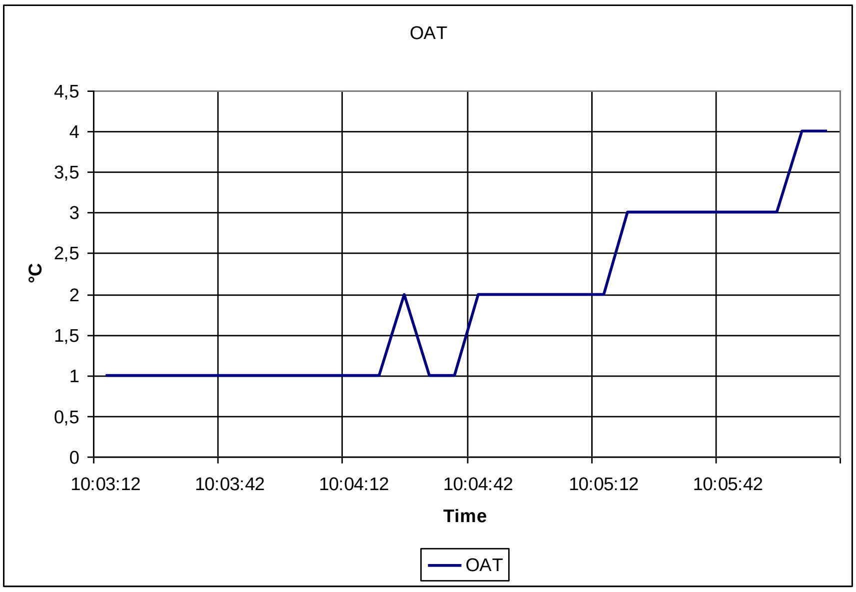
1.11.1. Pressure Altitude

The pressure altitude is measured from a pressure transducer calibrated on 1013 hPa. The values were corrected to show an agl value.
The parameter shows a steadily decrease in altitude of 787 ft/min. The lowest value of pressure altitude indicates the time of touchdown (10:05:48)



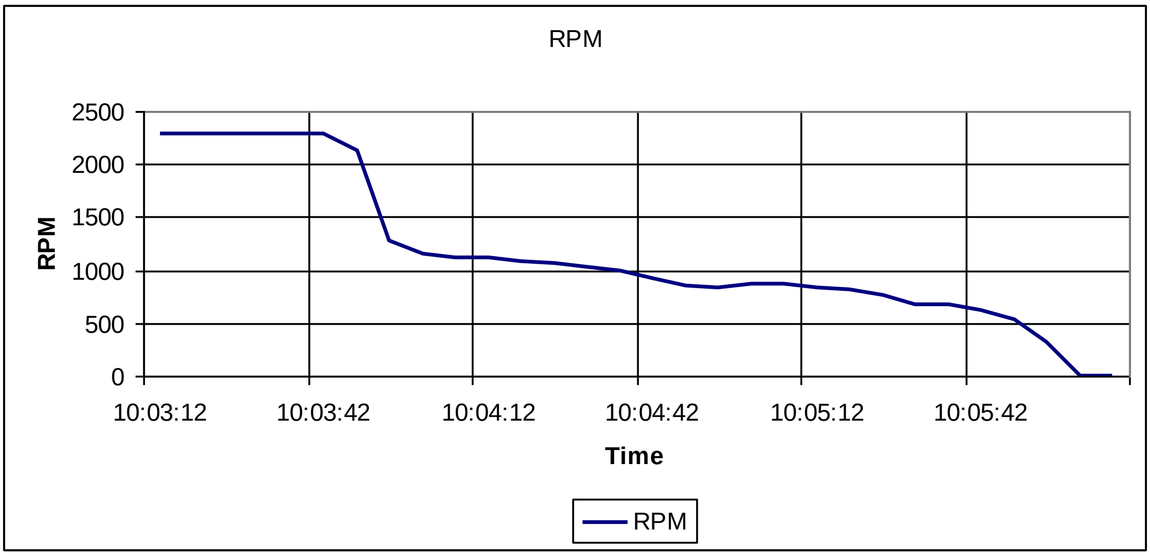
1.11.2. Outside Air Temperature.

The OAT is measured by a separate sensor, an Avidyne Magnetometer /OAT sensor – sn 24855).
The evolution shows an OAT of 1-2°C throughout the whole flight.
The OAT on ground, upon Take-off in EBAW is 4°C, identical to the value read when landing in Kiewit.



1.11.3. Engine RPM.

The engine RPM is generated by a tachometer installed on the engine. The parameter shows that the engine started to decelerate between 10:03:42 and 10:03:48.
The evolution shows a gradual decrease, until the RPM drops abruptly to zero at 10:06:00.



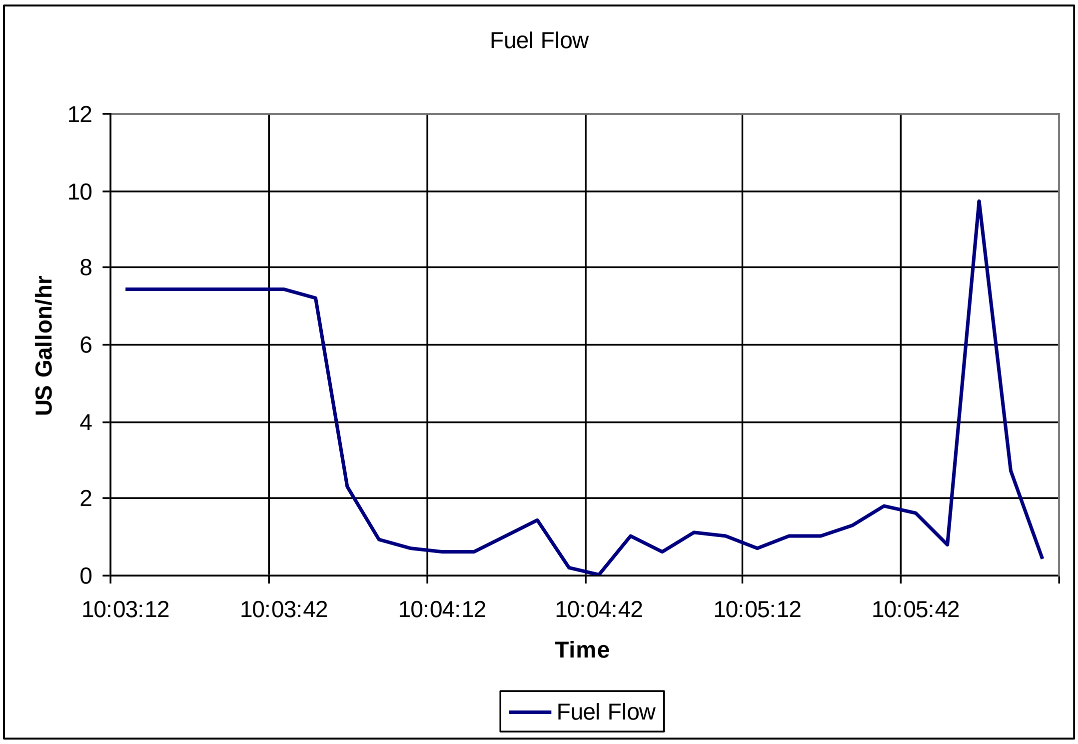
1.11.4. Fuel Flow.

The fuel flow parameter is measured by a dedicated flow sensor, a FloScan Series 200 Flow Transducer (IPC: P/N 84522-003 TRANSDUCER – Fuel Flow (Entegra)), mounted on the carburetor body.

The typical range of such transducer is 0.3 – 30 US Gallon per hour.

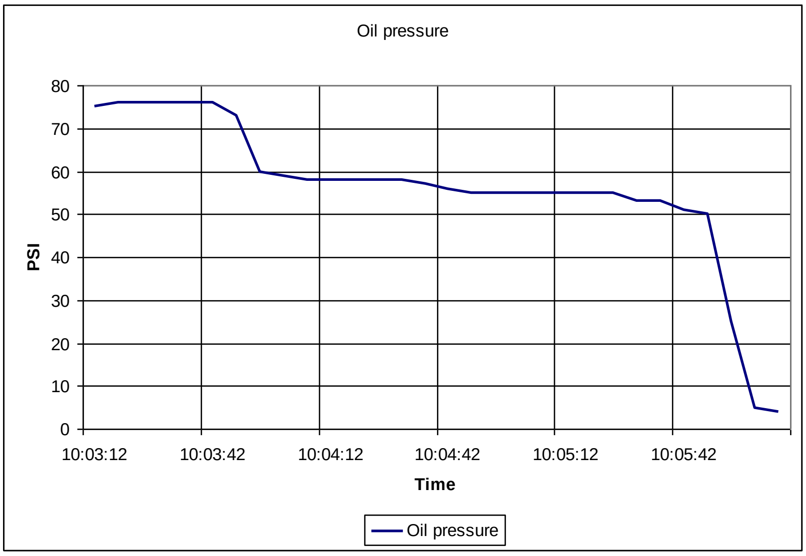
The evolution shows a drop in value at the same time the RPM starts to decelerate (between 10:03:42 and 10:03:48). It shows also 2 consecutive very low value around 10:04:42, and a peak at 10:05:54.

The Fuel flow measured during the emergency landing simulation (between 10:04:00 and 10:05:48) is on average 0.79 US Gal/hr, with values ranging from 0 to 1.4 US Gal/hr.



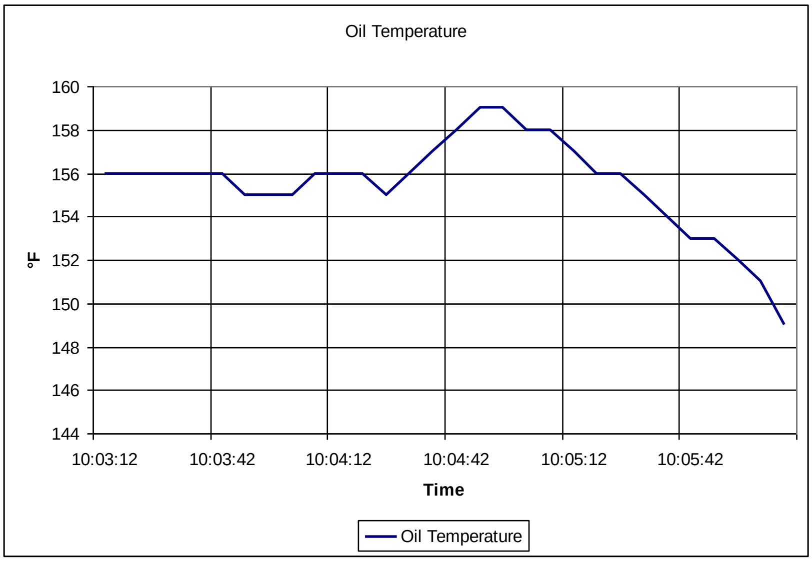
1.11.5. Oil Pressure.

The oil pressure is measured by a pressure transducer mounted on the engine.
The evolution shows a drop in value, at the same time the engine starts to decelerate, until 10:05:48, when the pressure decreases abruptly towards lower values.



1.11.6. Oil Temperature.

The Oil temperature shows no changes upon the engine rpm changes, then the temperature increases somewhat before decreasing steadily.

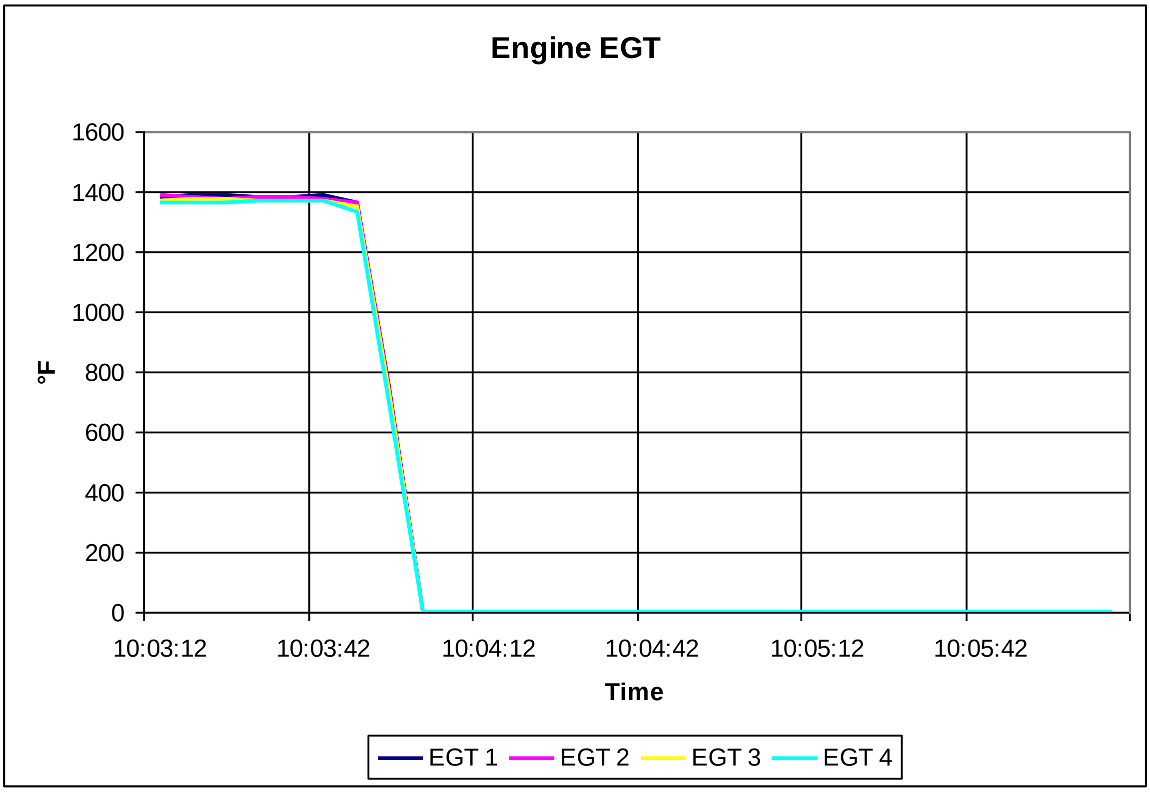


1.11.7. Engine EGT.

The EGT is measured by Type K thermocouples (Chromel / Alumel) placed on the exhaust tube from each cylinder.

The evolution shows the same pattern as the engine RPM; a start of decrease between 10:03:42 and 10:03:48.
The evolution shows a decrease towards 0 in 12 seconds (at 10:04:00, all 4 parameters reads 0).

Temperature below 600 °F are not measured by the EGT instrument, and therefore read 0.

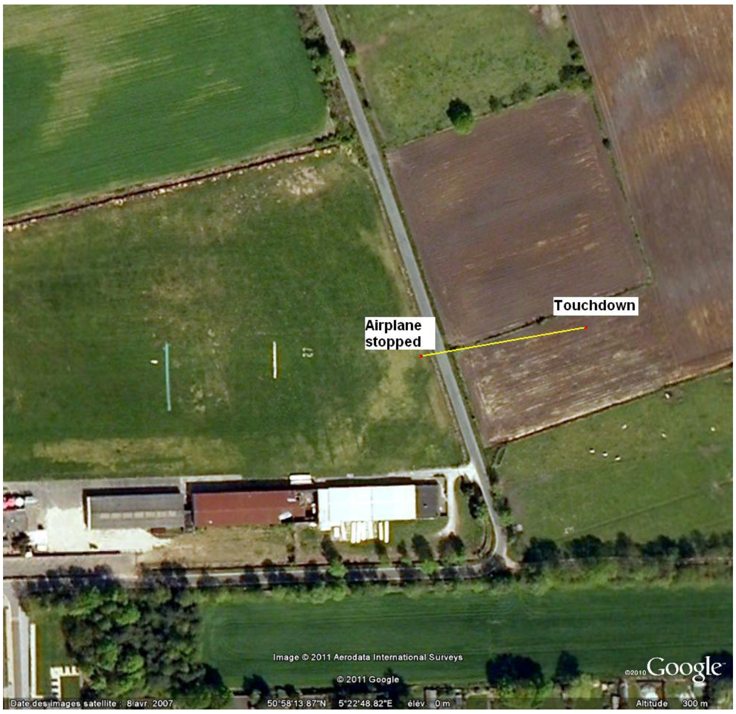


1.12 Wreckage and impact information.

The airplane touched down in the field in front of the airfield, crossed a road, and came to a stop, after hitting concrete pillars and barbed wires.

The road is made of concrete, and bordered by 2 ditches.

The airplane stopped 80m from the initial touchdown point.



Findings during initial assessment.

Position of the controls;
Throttle: close
Carburetor heat: 2/3 off
Mixture: lean (cut-off position)
Master switch: OFF

Engine controls friction: low friction.

Fuel tank selector: LH
Flaps lever: 2 (25°)
Fuel pump: OFF

Battery Master: OFF
Alternator: OFF
Stby alternator: OFF

Wreckage assessment
The engine controls were inspected, all were still attached and functional. The carburettor heat control was blocked into position.

A quantity of ca 12cl fuel was drained from the carburetor bowl. The fuel was clear and no abnormal contamination was found.

Both propeller blades were bent backwards, one blade showing more damage than the other.

1.13 Medical and pathological information.

Not applicable

1.14 Fire.

There was no fire.

1.15 Survival aspects.

The two occupants applied the procedure for emergency landing, including the tightening of the harnesses and belts. They climbed out of the airplane safely.

1.16 Tests and research.

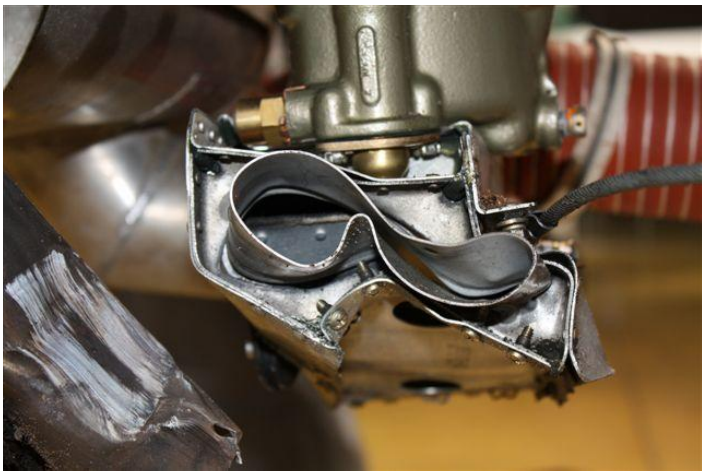
1.16.1. In-detail examination of the airplane and engine

The ignition plugs were checked;
Two plugs showed a wet aspect (cylinders 2 and 4 – lower side) due to presence of oil; owing to the inclination of the engine after the crash, it is likely that oil came back into the cylinder through the rings.
All other ignition plugs were normal.

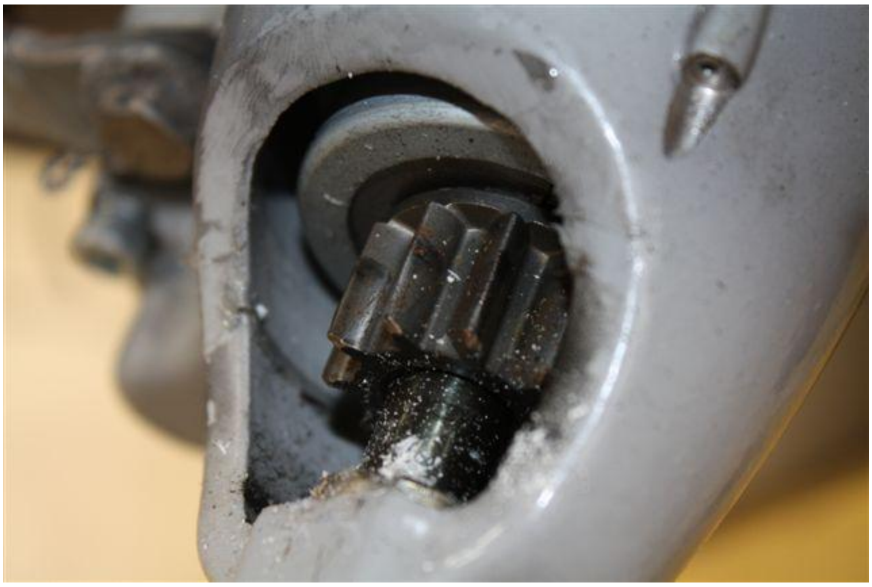
The magnetos were also checked by rotating the engine manually and sparks were generated on all ignition plug connections.

The fuel flow sensor filter was checked; it does not show any contamination.

The carburetor heat box was found crushed by impact; the valve was found 2/3 in the ‘cold’ position.

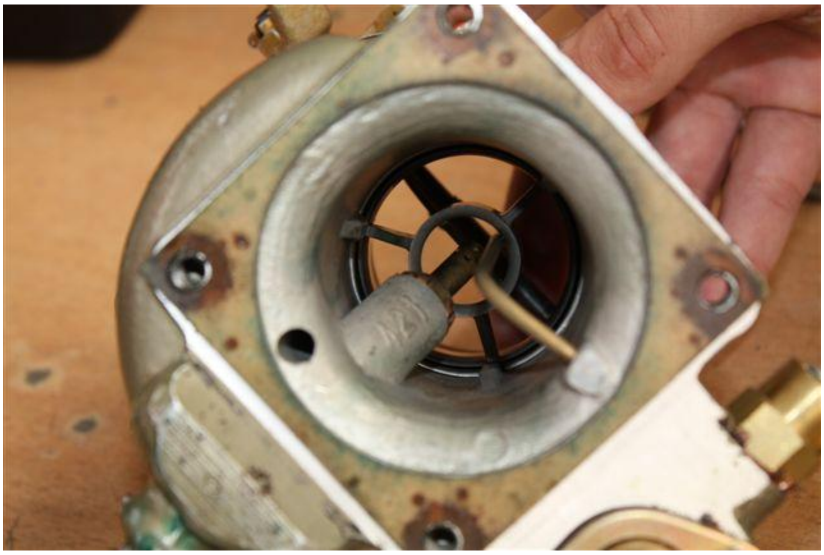


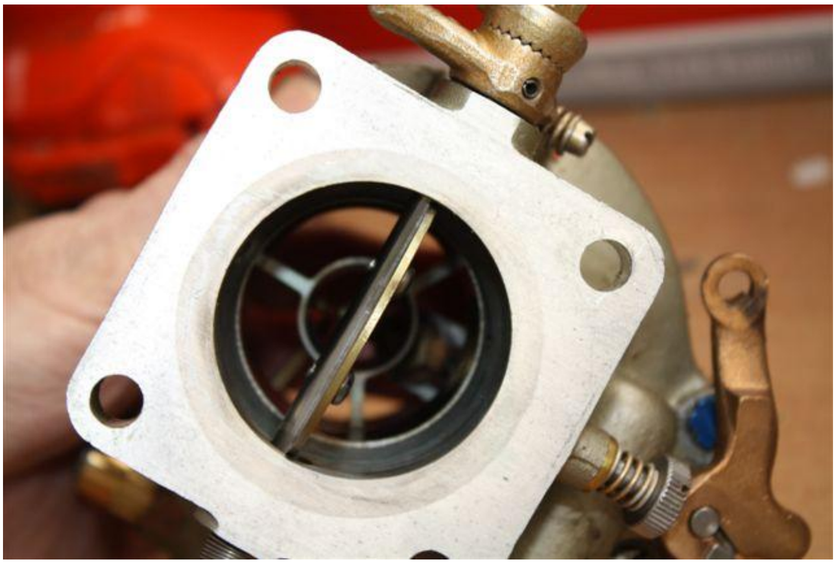
The starter clutch was inspected, and the gear still showed traces of the in-flight attempt to restart the engine.



The carburetor (type LW-15986-70, Model MA-4SPA, pn 10-5217, sn CK817940) was removed and inspected.
The acceleration pump was tested using the fuel remaining in the pump housing.

The carburetor bowl was clean and no contamination was found.





The engine controls (throttle, mixture, carburettor heater) assemblies were inspected; the control shaft were found in place and connected to the corresponding valves and control levers.

The nozzle assembly was removed, inspected and found free of contamination, as was the Mixture Control Metering Valve Assembly.

The air intake was inspected, and no pre-impact obstruction was found.

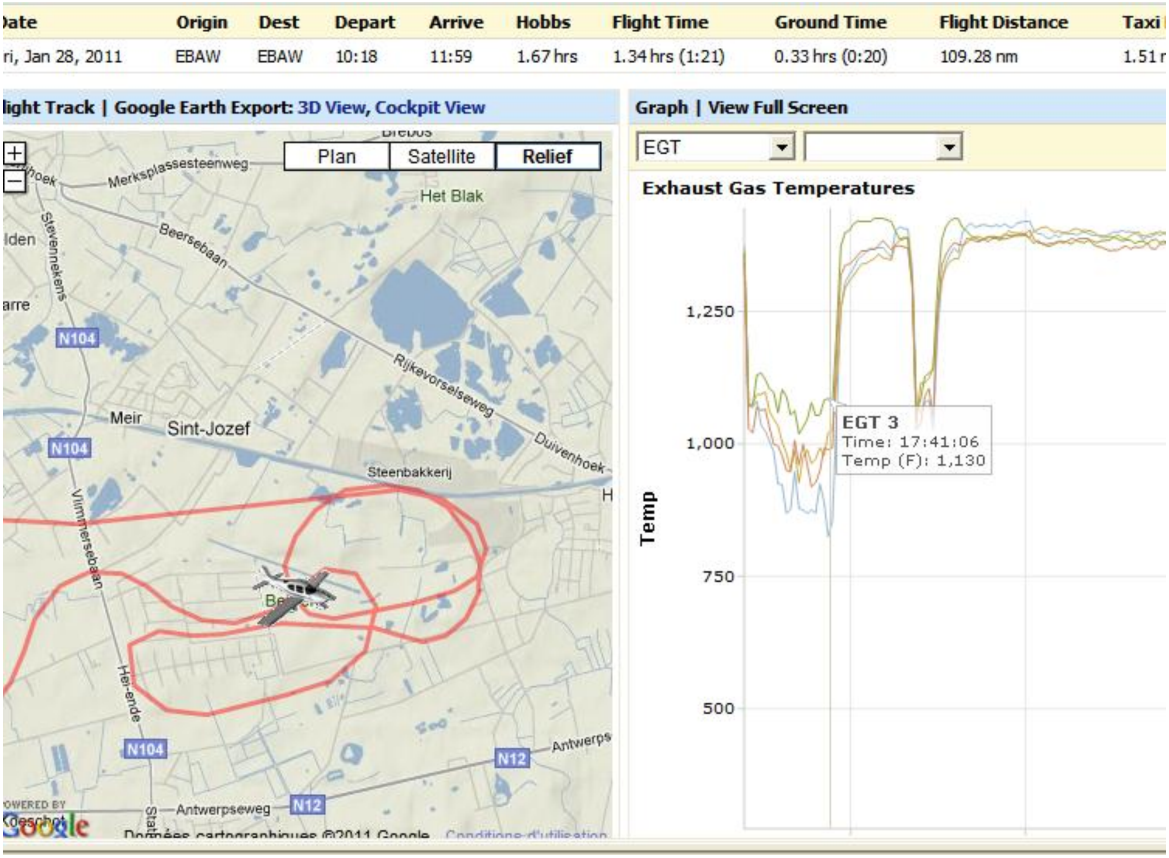
The 2 exhaust silencers were inspected, and no pre-impact obstruction was found.

The engine was manually rotated, showing mechanical continuity between the crankshaft and the valve train.

1.6.2. Engine parameters

In order to determine the 'normal' working of the engine in similar circumstances, and to provide an adequate comparison base, the database of downloaded Engine parameters was searched for other flights of the same airplane with the same engine.

At least 4 previous flights showed exercises of Practised Forced Landings, with flight and engine parameters similar to the ones pertaining to the accident. All these flights showed that the EGT stabilized around 1000 °F.



Example of EGT data for a PFL exercise.

With respect to the fuel flow, the data collected show for all an average of 0.99 US Gal/hr with values ranging from 0.6 to 1.2 US Gal/hr.

1.17 Organizational and management information.

1.17.1. BAFA Training School.

The Ben Air Flight Academy is a Flight Training Organisation approved by BCAA for compliance with the King's Order of 4 March 2008, and the Joint Aviation Requirements JAR-FCL 1.

The Approval Certificate B/FTO 006 was first issued on 14 March 2001 and last revised on 9 November 2009

The Organisation is defined in a series of Manuals:

- FTO Quality Manual
- FTO Operations Manual
- FTO Training Manual

Training Handbook.

The VFR training is supported by a BAFA-developed training handbook, covering all the topics of the JAR-FCL.

On the subject of "carburetor icing", the handbook describes the following:

Chapter 3: Basic Flight Maneuvers; Basic Flight Page 3-11

Air Exercise 4G	The effect of carburetor heat

- Carburetor heater should be used whenever carburetor icing is suspected. Icing can occur between +20°C and even more, and -20°C.
- If the aircraft has no carburetor inlet temperature gauge, use the heater always in the following cases:
    - In moist air except when using full power
    - Engine rough running (it might be a possible cause)
    - RPM decay
    - Before reducing power for descend.

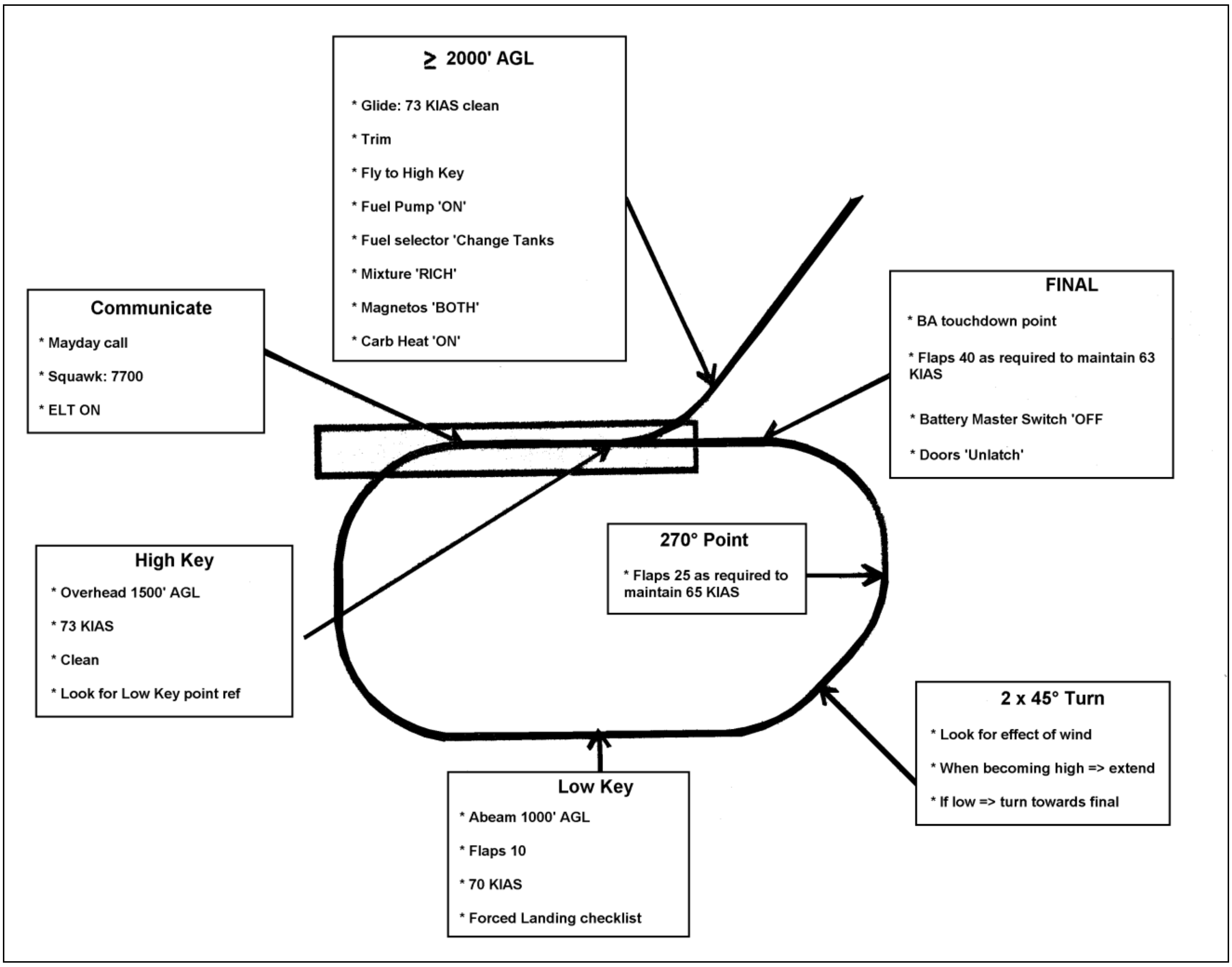
- If the aircraft has a carburetor inlet temperature gauge installed, use the heater when the gauge indicates between +10°C and -10°C and in conditions described above.

- Use the heater by pulling the carburetor heat control knob fully down => CARBU ON.

- Using carburetor heater may require a mixture adjustment for smooth engine running (use EGT).

The Practised Forced Landing procedure itself is described in the handbook under Chapter 12 – Non Normal – Emergency situations – Power-off accuracy approaches – Chapter 12.9.4. Forced landing sequence.

The Power off approach profile is as follows (Page 12-37):



The procedure adds (page 12-33):

> If the engine fails at a lower heights:
> 1. Less time will be available for planning. Flying the airplane is priority number one.
> 2. Execute a part of the standard pattern if possible.
> 3. As from 1000ft only a left turn, or a straight in; depending on wind and suitable field available
> 4. (…)

Further to a complete and extensive description of the procedure, the handbook outlines the differences between the real procedure and the simulated one. Among other, the handbook states:

> "- Warm the engine regularly: every 1000 ft in a descent. In dual the instructor will perform this action".

1.17.2. Skill Test.

Skill test are performed in accordance with the King's Order of 4 March 2008. The details are defined in the Circular CIR/FCL 8 (Edition 4, dated 11/2008) issued by the BCAA.

In particular:

- Item 14:
  The Flight program is defined in Appendix 1; Section 5 deals with "Abnormal and Emergency situations", including the performance of Practised Forced Landings (item b and c).
- Item 18.
  The candidate may repeat one time each maneuver or test procedure.

1.18 Additional information.

Not Applicable.

1.19 Useful or effective investigation techniques.

Not Applicable.

2. Analysis.

2.1. The flight

The performance of the PFL exercise itself was somewhat disturbed by the fact that an aircraft was flying in the circuit in front of OO-TMI. This led the pilot to stretch somewhat the descent.

As a consequence of the above, the airplane was too low in short final.

In final, the airplane was gliding at a height of 230 ft at a distance of 953m from the threshold.

If we consider the normal glide performance of the PA-28 (AFM Section 5, Page 5-27), the airplane would land 150m short of the threshold, which it eventually did.

In addition, the recommendation to warm the engine regularly (i.e. moving briefly the throttle forward) was not applied; this could have given an early warning of the engine failure.

The performance of the PFL led to the airplane being too low on short final, however, it must be emphasized that this operation was supposed to be a simulation, as outlined in the BAFA Training handbook and the regulatory conditions of the skill test, as defined in CIR/FCL 8. Engine power was supposed to be available.

2.2. Physical examination.

The damage to the propeller show the engine was not producing power at the time of impact

The carburetor valve was found almost in the ‘cold’ position, but this position was obviously influenced by the impact.

In conclusion, the physical examination of the engine did not reveal pre-impact anomalies that could explain the lack of reaction of the engine upon landing.

2.2. Engine failure.

The EGT parameter shows that the EGT of all 4 cylinders drop to zero within 12 seconds of the power reduction. Relating this to the EGT evolution of similar exercises, we can conclude that the engine stopped working at 10:04:00.

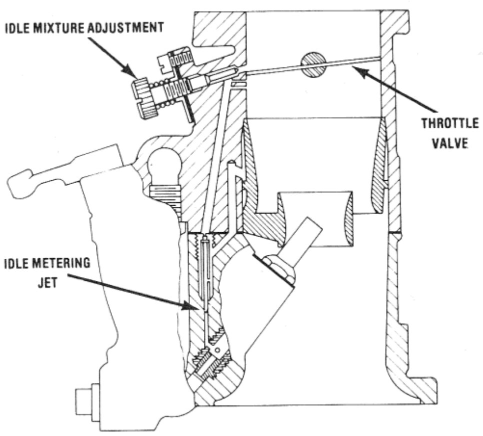
The engine failure could not be detected by the pilots; the noise would have been similar to the noise of a normal idle windmilling engine. The EGT indicator starts indicating from 1100 °F, thus would normally indicate nothing.

The RPM would only gradually drop, as the engine would be windmilling.

2.3. Fuel and Air Flow

At idle power, fuel is drawn from the float bowl of the carburetor through an internal channel in the carburetor body, and air is mixed with this fuel, and discharged through a hole located downstream of the throttle Valve.

The Throttle Valve is almost closed when the engine is idling, and all of the air that flows into the engine must pass around its edges. Because of this restriction, the air has a high velocity, and the pressure at the edge of the valve is low, pulling the fuel out into the air as a spray through the discharge hole.



Carburetor cut-away (typical)

The fuel flow measured by the fuel flow transmitter during the two minutes preceding the impact shows an average value significantly lower than the value usually encountered during engine power loss in flight exercise.

The value is even dropping to zero for 12 seconds, meaning that something was blocking totally either the airflow or the fuel flow. This obstruction caused the combustion to stop shortly after the power reduction and the engine started windmilling.

These low fuel flow values were followed by higher values, (within the measuring range of the fuel flow transducer), meaning there was still fuel available, but this led to no combustion of the mixture of fuel and air.

The phenomenon described above is symptomatic of the icing of the carburetor, when the pressure drop within the carburetor will cause the condensation of the water present in the air, and bring the water below its freezing point. The internal surfaces of the carburetor will be covered with this ice that will gradually block the air flow through the venturi.

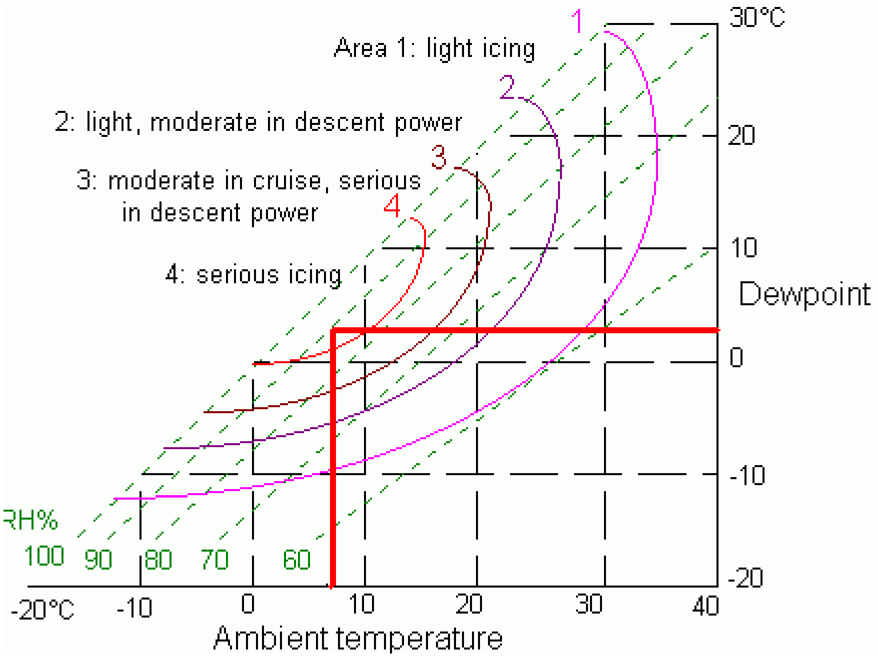
The flow restriction will upset the fuel/air ratio outside the operating range, such that when opening the Throttle Valve, the combustion inside the cylinder will not occur.

The combustion stopped shortly after the power reduction; this was an indication that the carburetor icing conditions were already present, and that ice could have been liberated, and clogged the fuel/air openings.

2.4. Carburetor icing conditions

METAR in EBBR and EBLG indicate an outside air temperature of 6°C with a dew point of 3°C. The OAT measured by the airplane indicates an OAT on ground of 4°C.

These values indicate conditions that were conducive to carburetor icing.



Both pilots state the carburetor heat was applied at the beginning of the flight, and further no longer applied for the rest of the flight. It was further only selected ON, together with the retarding of the throttle upon the start of the engine power loss in flight exercise.

The carburetor heat box takes ambient air from the engine compartment and is warmed up by flowing around an engine exhaust pipe. This system cannot provide a sensible warming if not applied well before any power reduction.
Applying carburetor heat at the same time the throttle are held back does not provide an adequate protection against carburetor icing, for serious icing conditions (all power rating) as encountered.

3. Conclusions.

3.1 Findings.

The airplane was in airworthy condition.

The pilots were qualified for the flight (Skill Test).

No technical condition was found on the airplane to explain a pre-impact failure of the engine.

The engine stopped working 2 minutes before impact.

The meteorological conditions were conducive to carburetor icing.

The carburetor heat was applied briefly at the beginning of the flight, and further no longer applied for the rest of the flight, until applied during the power reduction at the start of the Practised Forced Landing exercise.

3.2 Causes.

The cause of the accident is a missed approach during the simulation of a Practiced Forced Landing (PFL), combined with the actual failure of the engine due to carburetor icing.

4. Safety recommendations.

4.1. Recommendation 2011-P-6

AAIU(Be) recommends BAFA to study the possibility to equip their fleet of PA-28 with the optional carburetor ice detector, or similar device.

4.2. Recommendation 2011-P-7

AAIU(Be) recommends the Flight schools to use the content of this report (and others on the same subject), in order to underline adequately the potential dangers of carburettor icing.

In particular, the instructions given to the student should emphasize the importance of the application of the carburettor heat procedure for the PFL procedure, for which the carburettor heater should be put “ON” sufficient time (to be defined) before the power reduction to idle.