Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

Air Accident Investigation Unit - (Belgium)
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Safety Investigation Report

ACCIDENT TO PIPER PA-44-180 AT EBST ON 11 SEPTEMBER 2011

Ref. AAIU-2011-23
Issue date: 14 January 2013
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, Article 16 of the EU regulation EU 996/2010 stipulates that the safety recommendations made in this report do not constitute any suspicion of guilt or responsibility in the accident.

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 Henri Metillon and Sam Laureys
The report was compiled by Henri Metillon and was published under the authority of the Chief Investigator.

NOTES:

- For the purpose of this report, time will be indicated in UTC, unless otherwise specified.
- ICAO document 9859 “Safety Management Manual” was used to identify the hazard and the consequences related to the accident.

AAIU-2011-23

SYNOPSIS

Date and hour of the accident:	11 September 2011 at 16:00 UTC
Aircraft:	Piper PA-44-180
Accident location:	EBST Brustem Airfield
Aircraft owner:	Ben-Air Flight Academy
Type of flight:	Training (local)
Persons on board:	3

Abstract:
On this day, the airplane was used to familiarize two student pilots with different situations of flight with one inoperative engine. As planned, the instructor started a L/H engine failure simulation after the take-off. The student pilot stabilized the airplane and flew in the airfield circuit up to the short final. At that moment, the student pilot claimed to be unable to adequately align the airplane to the runway. The instructor took over the control and landed the airplane. As the airplane was rolling on the runway, the instructor re-configured the controls of the airplane for take-off, when suddenly the airplane turned to the left and headed towards an embankment located perpendicularly to the runway. The instructor decided to expedite the take-off in order to recover control and to avoid a crash onto the embankment. The airplane had passed just to the right of the embankment when one wing stalled causing a loss of control and a few violent contacts with the ground.

Cause(s):
The cause of the accident is a loss of control during a touch and go performed with an undetected inoperative engine.
The left hand simulated inoperative engine probably became inoperative due to carburettor icing.

Hazard identified during the investigation [1]:
Meteorological conditions (temperature, humidity) inducing a risk of severe carburettor icing (any engine rating).

Consequence [2]:
Engine failure (SCF-PP) and loss of control – in-flight (LOC-I)

1 Hazard – Condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

2 Consequence – Potential outcome(s) of the hazard

1 Factual information.

1.1 History of flight.

The airplane took off from its home base EBAW airport with one instructor and two student pilots on board. The purpose of the flights was to give instruction on VMCA and one engine inoperative procedures.

After a series of exercises with the first student, the airplane landed in EBST, and the student pilots swapped positions.

The airplane took off with the second student seated left side, at the controls. The first part of the flight consisted of a demonstration of VMCA (Minimum Control Airspeed in Take-Off configuration) followed by a series of simulations of flight with one engine inoperative.

Arriving back at EBST, the airplane went into the normal circuit (both engines operating), followed by a touch and go.

Upon take-off, the crew performed a simulation of an engine failure after take-off. This exercise was adequately managed by the student pilot, and after that, the airplane was reset into a normal, both engines operating, configuration.

The airplane remained in the circuit for a second touch and go.

After the second take off and leveling off, a simulation of single-engine approach and landing was initiated by the instructor. The student pilot stabilized and flew the airplane in the airfield circuit up to the short final.

However, the flying student pilot had difficulties in short final to hold the airplane on the centreline of the runway and the instructor announced “I have the controls”, took over and landed the airplane.

During the landing roll, the instructor raised the flaps as preparation for take-off and at that moment, the airplane turned violently to the left as witnessed by the student pilot and the instructor. However, the student pilot sitting on the rear seat stated that the tendency to the left was already present, and aggravated when the instructor pilot retracted the flaps.

As the airplane headed in the direction of a raised embankment located on the LH side of the runway, the instructor decided to take-off, rotated the airplane, and retracted the landing gear.

Unfortunately, the pilot could not really change the airplane’s heading and increase the airplane’s speed. The airplane was flying at low speed at a few meters height from the ground.

The airplane succeeded to pass just to the right of the embankment but after that, the left wing stalled and hit the ground. Then the nose ploughed into the ground, followed by the right wing and the tail section.

The airplane was destroyed by several cart-wheeling impacts and came to a rest on its belly completely disintegrated.

The occupants, shocked but uninjured, evacuated the airplane through the normal door located right side of the fuselage. (The emergency exit located left side of the fuselage was not used).

No occupant of the airplane remembered after the crash having heard a positive transfer of the controls during the landing roll.

1.2 Injuries to persons.

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	3	0	0	3
Total	3	0	0	3

1.3 Damage to aircraft.

Figure 1: view of the airplane as seen just after the crash

Figure 2: airplane as seen the day after the crash

1.4 Other damage.

None.

1.5 Personnel information.

Instructor Pilot:

Sex:	Male
Age:	36 years old
Nationality:	Belgian
Licence:	Commercial Pilot Licence (Aeroplane) first issued on 29 May 2007. Valid until 29 May 2012.
Ratings:	SEP (Land) valid until 31 May 2013 MEP (Land) and IR(A) valid until 30 September 2011 CRI(A) valid until 30 April 2014 FI(A) valid until 30 September 2014
Medical:	Medical certificate Class 1 was valid until 12 February 2012.
Experience:	Total flight hours experience: 1522h Total flight hours experience as PIC: 1340h, from which 60h on MEP and 57h on Piper PA-44-180. IFR total flight hours experience: 303h Total flight hours experience as instructor 662h from which 25h MEP (Exclusively on Piper PA 44-180).

Summary of the flight experience during the four weeks preceding the accident:

The instructor pilot performed 8 flights from which 5 were instructional flights in the period between 13 August 2011 and 11 September 2011(date of the accident).

Five flights were performed using fuel injected engine airplanes and the three remaining flights were performed using carburetted engine airplanes.

The last flight before the date of the accident was performed on 20 August 2011 using a Piper PA-38-112 airplane, which means 21 days before the accident.

Student Pilot:

Sex:	Male
Age:	25 years old
Nationality:	Belgian
Licence:	Private Pilot Licence (Aeroplane) first issued 09 Augustus 2010. Valid until 09 August 2015.
Ratings:	SEP (Land). Valid until 31 August 2012.
Medical:	Medical certificate Class 1 was valid until 2 April 2012.
Experience:	Total flight hours experience: 154h. Total flight hours experience as PIC: 87h from which 46h alone on board. 2h54 experience on MEP, Piper PA-44-180.

Second student pilot:

Not relevant (As he was a passenger/observer, seated on the rear seat).

1.6 Aircraft information.

Airframe:

Manufacturer:	PIPER AIRCRAFT, INC.
Type:	PA-44-180
Serial number:	4496268
Built year:	2008
Registration:	Belgian registered
Certificate of registration:	Number 10304. Delivered by BCAA on 20 March 2009.
Certificate of airworthiness:	Form 25 delivered by BCAA on 23 March 2009.
Airworthiness Review Certificate:	EASA Form 15b valid until 2 April 2012
Certificate of Authorized Flights:	BCAA delivered for VFR flights, Night Flights in Visual Flight Conditions and IFR Flights Day and Night. Valid until 7 April 2012. 1509FH. (See § 1.18 Additional Info.)
Airplane total time:	1509h

Engines:

Manufacturer:	LYCOMING
Type L/H:	O-360-A1H6
Serial Number L/H:	L-41453-36E
Total flight hours L/H:	1509FH
Type R/H:	LO-360-A1H6
Serial Number R/H:	L-907-71E
Total flight hours R/H:	1509FH

Propellers:

Manufacturer:	HARTZELL
Type L/H:	HC-C2YR-2CEUF
Serial Number L/H:	AU13826
Total flight hours L/H:	1509FH
Type R/H:	HC-C2YR-2CLEUF
Serial Number R/H:	AU13771B
Total flight hours R/H:	1509FH

General description

The Piper PA-44 Seminole is an American twin-engined light aircraft manufactured by Piper Aircraft.
The PA-44 is a development of the Piper Cherokee single-engine aircraft and is primarily used for multi-engine flight training. The PA-44 features a high T-tail similar to the T-tailed Arrow IV.
The Seminole was first certified on March 10, 1978 and it was built in 1979-82, in 1989-90, and again since 1995.
The last production Seminoles (including the airplane) are equipped with two 180-hp (135 kW) Lycoming O-360- A1H6 engines. The right hand engine is a Lycoming LO-360- A1H6 variant, which turns in the opposite direction to the left hand engine. This feature eliminates the critical engine and makes the aircraft more controllable in the event that an engine needs to be shut down or fails.

General characteristics

Crew: 1 pilot
Capacity: 3 passengers
Length: 27 ft 7.2 in (8.41 m)
Wingspan: 38 ft 8 in (11.77 m)
Height: 8 ft 6 in (2.59 m)

Airplane Weight & Balance

Empty 7,42 Lb
Empty CG: 86,44 In
Max take-off weight: 3,800 lb
Useful Load: 1092,58 Lb

Performance

Maximum speed: 202 kt
Cruise speed: 155 kt
Range: 1,000 miles (1,630 km)
VMCA Air Minimum Control Speed: 56 KIAS
VVSE Intentional One Engine inoperative Speed: 82 KIAS

Certification

The Piper PA-44 Seminole was originally FAA certified following FAA TCDS NO. A19SO and was later EASA certified following EASA TCDS reference EASA.IM.A.232.

Pilot's Operating Handbook

The applicable "Pilot's Operating Handbook and FAA approved airplane flight manual" was PA-44-180 report VB: 1942 revision 2 dated October 15, 2008.
Section 3 "Emergency Procedures" provides the recommended procedures for coping with various emergency or critical situations. It has to be noted that all the available emergency procedures incorporated in this section pertain to actual emergencies and not simulated emergencies.
By contrast, the section 4 of the POH provides, in chapter 4.49, information on how to simulate a one inoperative engine flight without actually shutting down one engine. This section provides only guidance limited to the propeller RPM setting to obtain an approximate zero thrust.

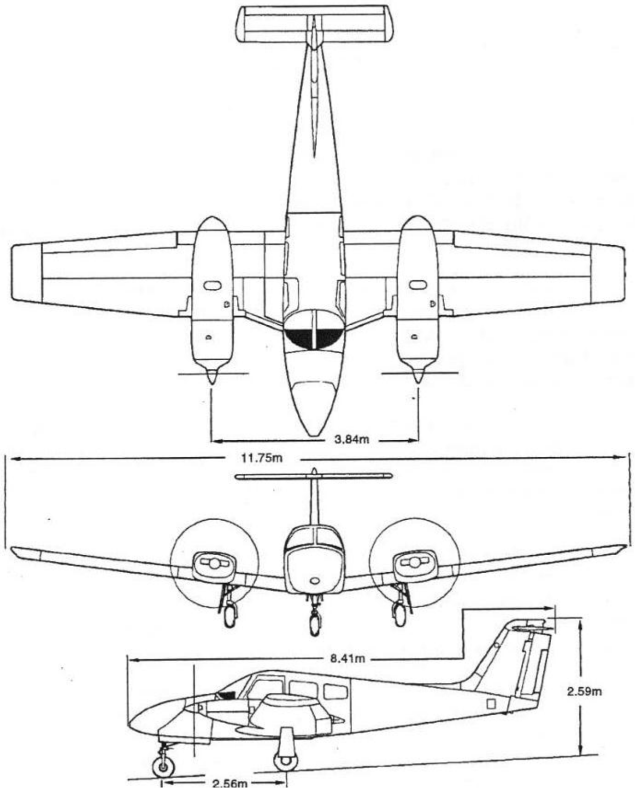


Figure 3: Airplane general view and dimensions

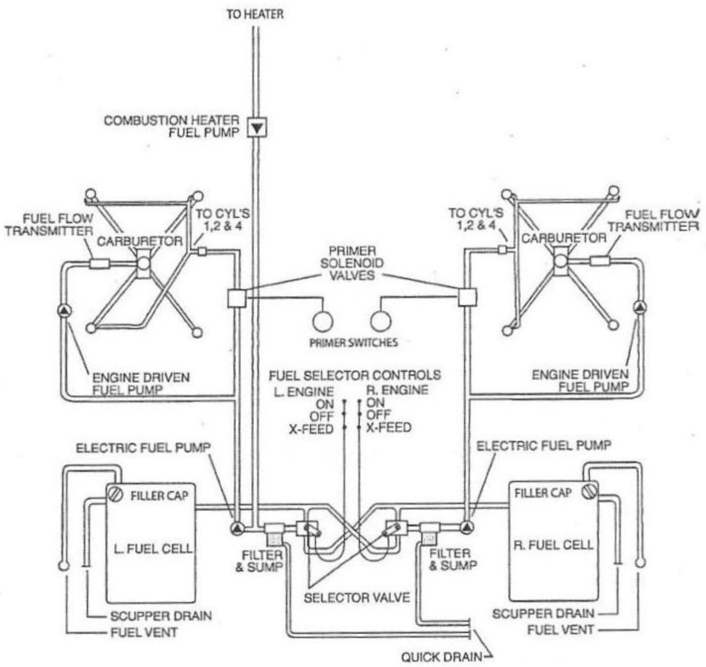


Figure 4: Fuel system schematic.

Maintenance

The airplane maintenance was regularly performed by a BCAA approved Part 145 Maintenance Organisation in accordance with a BCAA approved maintenance program.

The following last maintenances were performed:

16 June 2011:	50h inspection at 1344h00.
8 July 2011:	100h inspection at 1396h42
5 August 2011:	50h inspection at 1444h06
7 September 2011:	100h inspection + additional 500h inspection items and correction of hold items.

(A copy of the last *"Aircraft Certificate of Release to service and Maintenance Statement"* reference WO n°4358/11 is enclosed at the end of this report).

Trouble reporting

"BAFA" Flight School uses a computerized system to record trouble reports.

The last trouble reports concerning the airplane were downloaded and inspected and it was found that the last one dated 9 September 2011 was not closed at the date of the accident and could be relevant for the accident investigation.

The following text was recorded:

Trouble report – Problem 41 discovered 09/09/2011 – 14:02. *Nose wheel steering: very sloppy to no reaction. Differential power and braking is a must, even for small steering adjustment*

Chronology of the Nose Wheel Steering Records:

7 September 2011:	100h inspection + additional 500h inspection items.
8 September 2011:	No abnormal condition of the steering system reported.
9 September 2011:	Instructor pilot reports that the efficiency of the nose wheel steering is considerably less than normal, in both directions.
10 September 2011:	Instructor pilot reports a degraded steering authority at very low taxi speed, in both directions.
11 September 2011:	Instructor pilot involved in the accident, being aware of the reported difficulties, checked the nose wheel steering and did not find any abnormal condition both during external inspection and when testing the steering during the taxi.

Despite the difficulties reported on 9 and 10 September, both pilots reported the airplane remained controllable on the ground using techniques one would use on an airplane without nose wheel steering.

1.7 Meteorological conditions.

Brussels and Liège airports METAR's, beginning at 15:20 and ending at 17:50, are enclosed at the end of this report.

As seen on both METAR's, showers of rain happened regularly around 16:00 UTC.

Based on the above METAR's the conditions recorded at EBST at the time of the accident would have been approximately:

Wind speed: between 11kt and 18kt
Wind Direction: between 200° and 210°
Temperature: 16°C
Dew Point: 14°C
Visibility: variable between 4400m and more than 10km
Ceiling: scattered between 600ft and 1900ft and broken between 1500ft and 4100ft.
QNH: 1009hPa

1.8 Aids to navigation.

Not applicable

1.9 Communication.

Not relevant

1.10 Aerodrome information.

Sint-Truiden Air Base was a pre-World War II Belgian Air Force military airfield located 6 km south of the city Sint-Truiden (504731N - 0051206E). After the war, a new jet runway (06/24) was laid down, although the wartime runways were resurfaced and remained in use for non-jet aircraft. This base, also known as Brustem Air Base (ICAO: EBST), was deactivated in 1996.

For the time being, the airfield is used by a civilian operator called
"Vliegveld Sint Truiden BVBA".

Since the airfield is operated by this civilian operator, the only runways remaining in use are 06/24. The runway's length was reduced to 1199 meter for the new civilian use.

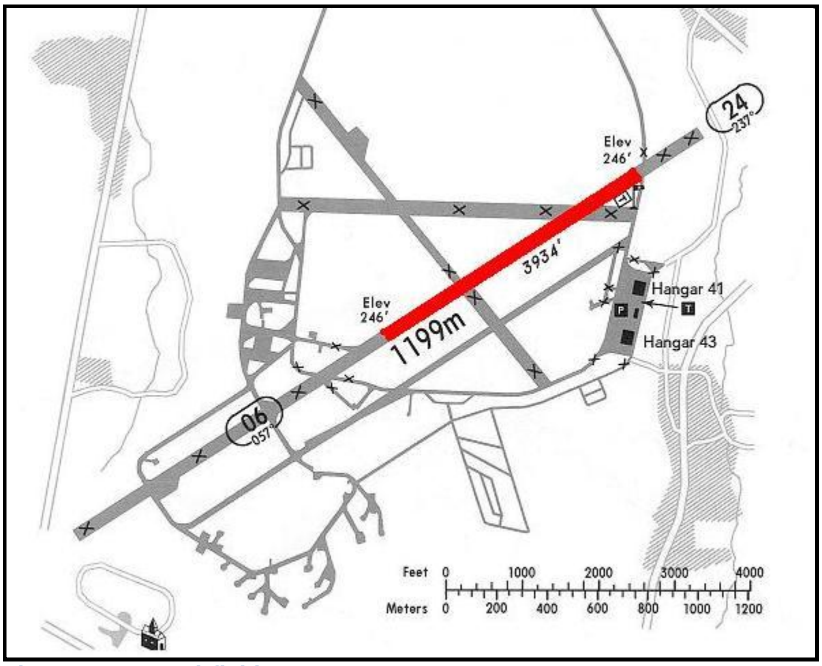


Figure 5: EBST airfield

The elevation of the airfield is 246 ft and it is equipped with a 1.199 m long – 50 m wide concrete runway oriented 058° / 238°. Maximum strength is 9000 kg.

The thresholds of the present 1.199 m long airfield are materialised by simple white transversal lines while the old military (significantly longer runway) thresholds markings have not been removed.

Figure 6: View of the new and the old threshold

The use of the airfield is subject to prior permission from the operator.
Both circuits are south of the runways at an altitude of 1200 ft AGL (Left hand circuit for 24 runway and right hand for 06 runway). The aerodrome is provided with a Flight Information Service (AFIS) called "Brustem Radio" - 119.975 MHz (Information only, no ATC).

1.11 Flight recorders.

No actual flight recorder was installed, however the airplane was equipped with an Avidyne Multi-Function Display and a Primary Flight Display able to record and store some data.

The MFD and PFD characteristics were:

- Avidyne FlightMax Entegra EX5000 series 700-00004-008 REV 04 (sn 98439470) Multi-Function Display (MFD) (EMax not installed).
- Avidyne FlightMax Entegra EXP5000 series 700-00006-002 Primary Flight Display (PFD) (sn M084018992) with 530-00138-000 software.

Both the Primary Flight Display (PFD) and the Multi-Function Display (MFD) were, at first sight, not damaged by the accident.

Avidyne FlightMax Entegra EX5000 Multi-Function Display (MFD)

The MFD samples and stores some data, therefore it has a memory function that allows the flight parameters to be recorded every 6 seconds.

However, the buffering that occurs within the MFD application software and the Microsoft Windows NT operating system on which it runs, combined with the time required to write the data to the flash drive itself can sometimes cause delays in the recording. There is no way to recover the data that was not written.

The following flight parameters are recorded every 6 seconds with a delay of approximately 30 seconds:

- Time
- Latitude
- Longitude
- Pressure Altitude
- Fuel Used
- AMPS
- Volts
- Fuel Quantity Left Tank
- Fuel Quantity Right Tank
- OAT

It includes also the following engine data for each engine:

- EGT 1,2,3,4
- Oil Temperature
- Oil Pressure
- RPM
- MAP
- Fuel Flow

Avidyne FlightMax Entegra EXP5000 Primary Flight Display (PFD)

The PFD samples and stores several data streams in a sequential fashion. Data from the integral attitude and heading reference system (AHRS) is recorded at a rate of 5 Hertz. Air data information, such as pressure altitude, indicated airspeed, and vertical speed is recorded at 1 Hz. GPS and navigation display and setting data are recorded at a rate of .25 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

Some engine data is also recorded.

There is neither buffering nor time required to write the data within the operating system of the PFD and consequently, the PFD includes high rate, high fidelity recording of flight data parameters and engine operating data.

A high-level description of the data recording capabilities of the PFD is enclosed at the end of this report.

It includes amongst other things engine data for each engine which is recorded at a rate of 1/6 Hz (Every 6 seconds):

- Percent power
- Manifold pressure
- RPM
- Fuel flow
- Oil temperature
- Oil pressure

Compared to the MFD, the PFD records the same engine data with the exception that there is no EGT record in the PFD.

For the purpose of the investigation, the read-out of the parameters recorded in the EX5000 series Multi-Function Display (MFD) and EXP5000 Primary Flight Display (PFD) was performed by ASP Avionics in Genk.

1.12 Wreckage and impact information.

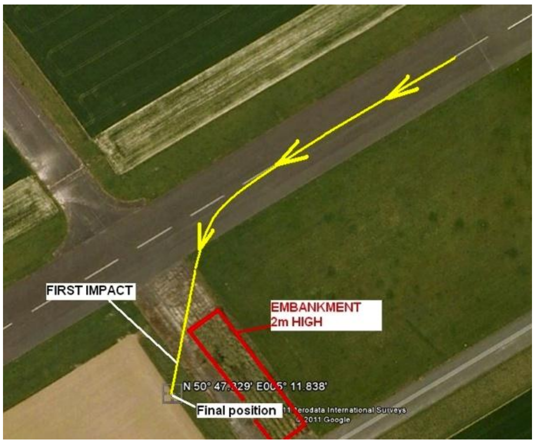


Figure 7: Google earth view of the crash site and approximate flight path based on pilots' declarations.

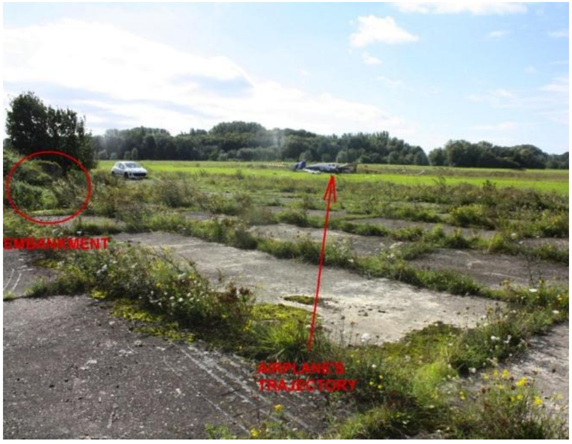


Figure 8: airplane's trajectory and view of the embankment

Figure 9: first significant impact traces

Figure 10: last impact traces with airplane in background

On the day after the crash the impact traces on the ground and the different debris positions were thoroughly noted.

The following sketch gives a general idea of the position and distance of the impact traces and remains.

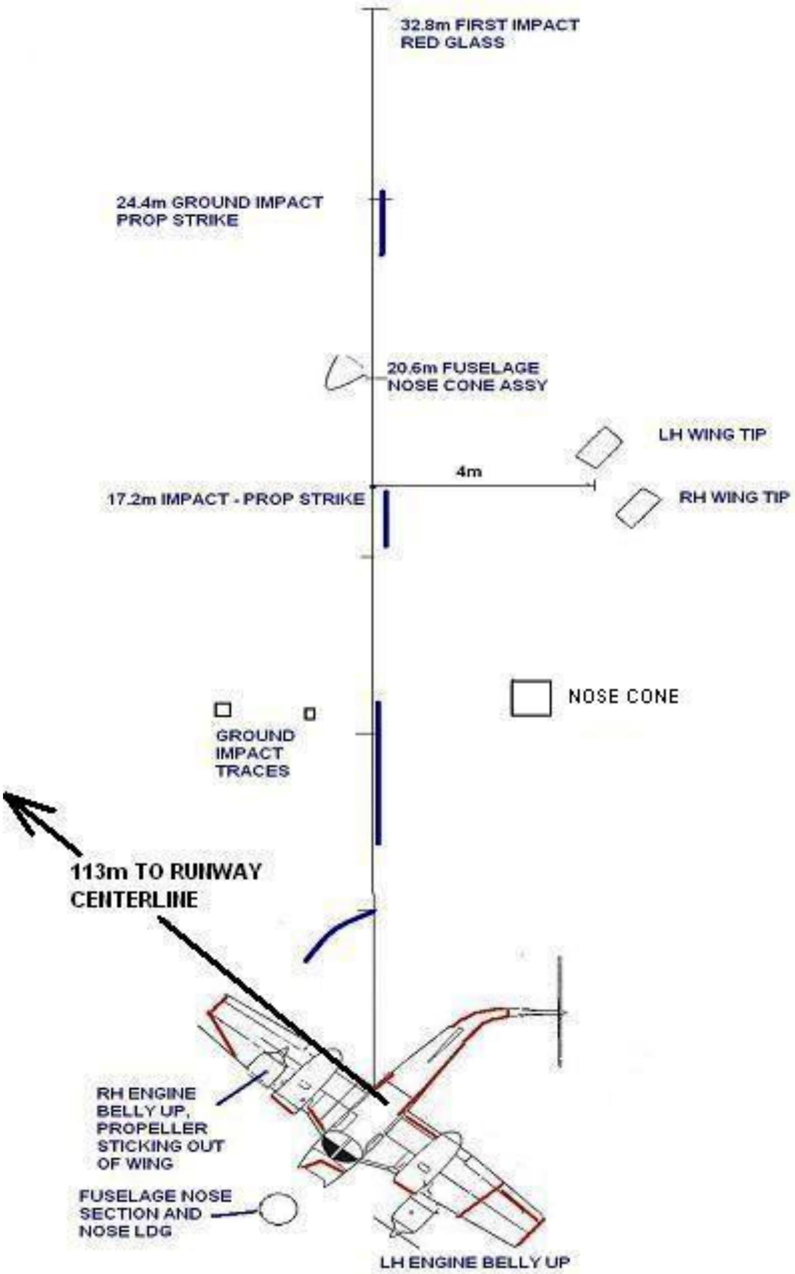


Figure 11: Position of the different impacts and remains (Not to scale).

Wreckage assessment

Fuselage:

The nose section that contains the nose landing gear bay was severely crushed and was torn away from the fuselage. The nose section was found upside down in front of the fuselage.

Cabin section almost intact; however, deformation at the height of the flaps on both vertical flanges of the fuselage.

Rear section of the fuselage was twisted to the left.

LH fuselage vertical flange aft the cabin is more damaged than RH side.

The battery which is normally installed in the nose section of the fuselage was retrieved on the ground under the aileron of the right hand wing.

Left Wing:

The left wing was severely bent upwards on the middle of the section outboard the engine nacelle.

The wing tip was found separated from the wing, nearly undamaged.

The leading edge was intact.

Engine nacelle: engine found upside down, in front of the wing leading edge and on the outboard of engine nacelle.

Aileron: inner half still in place, but crushed; outer half ripped off (found under front cabin wall).

Flap destroyed (2/3 found under the wing).

Right Wing:

Straight, wing tip missing with the exception of its lower panel

Leading Edge section outboard of the engine nacelle; crushed from 1/3 length up to the wing tip rib. Crushed perpendicularly to wing chord up to main spar at the wing tip.

Leading Edge section inboard of the engine nacelle: leading edge entirely cut by cables, pipes and wires when the engine was severed and went forward of the wing.

Engine nacelle: engine found upside down under the wing. The propeller was sticking out of the wing. Firewall missing, structure behind firewall torn open; fuel cell visible through opening. Aileron: almost intact. Flap: almost intact.

Tail:

The entire tail section was torn to the left.

No impact damage neither topside nor underside of the stabilisers.

No impact damage on the elevator or on the rudder.

Vertical fin was detached at the front fixation and rotated 90° rearward and to the left (rotated around the rear spar fixation).

Main spar of the fin bent rearward and to the left in the zone of the lower rudder hinge.

The clearance between the leading edge of the rudder and the main fin spar was larger than normal (due to the deformation of the fin main spar and lower rudder hinge).

As seen on the following picture, the rudder trim trailing edge was fully deflected to the right.

Figure 12: the rudder trim trailing edge was pointing to the right.

Figure 13: Picture of the rudder trim position.

Landing gear:
The fuselage nose section, including the nose landing gear, was severed and was found upside down forward of the fuselage.
The nose landing gear was found in relatively good condition in retracted position inside the wheel bay.
The left hand landing gear was retracted due to a lateral force toward the right that occurred during the accident. Some parts of the retraction system were bent or broken.
The right hand landing gear was extended but some parts of the retraction system were bent or broken by a lateral force toward the right that occurred during the accident.
A safety nut of the nose wheel bungee rod end was found loose.

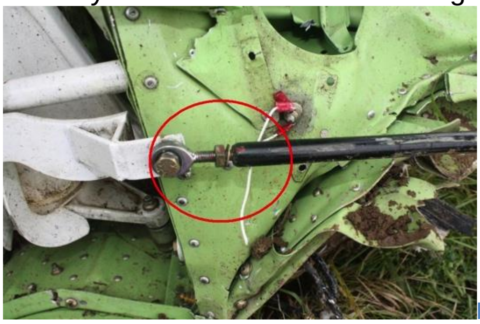


Figure 14: view of the nose wheel bungee rod.

1.13 Medical and pathological information.

Not relevant

1.14 Fire.

There was neither fuel leak nor fire. However, both engines were ripped off the airplane and as seen on the following picture, the right engine firewall was also torn away leaving the right hand fuel tank unprotected.
Moreover, one propeller blade ran through the wing structure not far from the fuel tank without piercing it.
The bladder fuel cell remained intact and the fuel did not escape from the fuel tank.

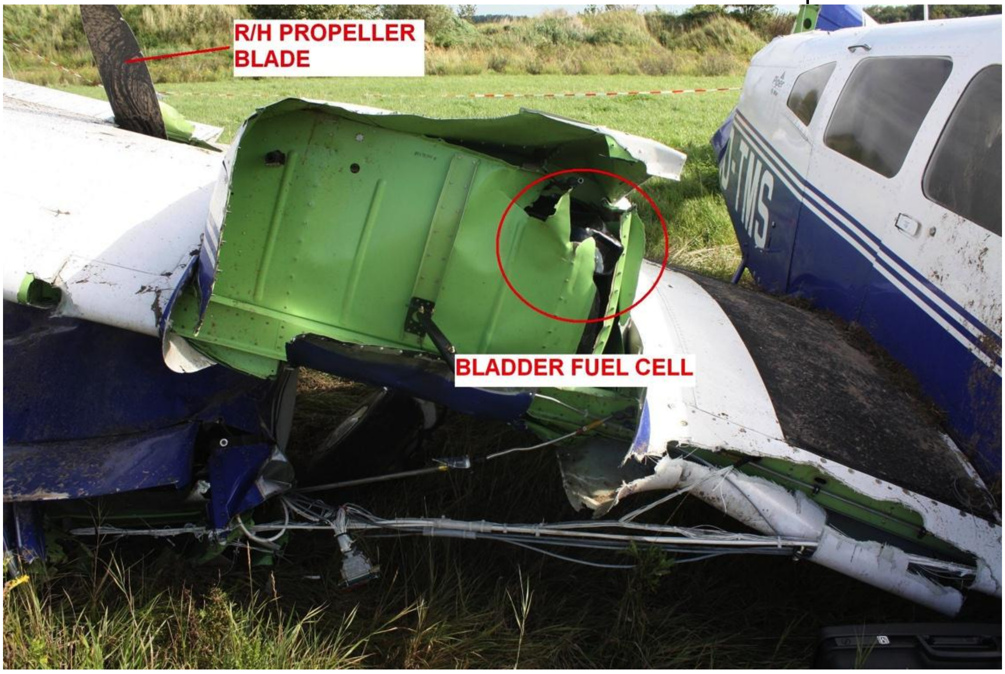


Figure 15: view of the right hand engine nacelle structure and fuel cell

1.15 Survival aspects.

Emergency exit.
The emergency exit consisting in an opening in the left side front window was not used to evacuate the aircraft.

Figure 16: view of the emergency exit (Not used after the crash).

Emergency Locator Transmitter.
The Emergency Locator Transmitter switch was armed and the RCC (Rescue Coordination Centre) received the two following emergency notifications from SARSAT Toulouse (*See notes hereunder about the Cospas-Sarsat system*):

- Detection time: 1600UTC by SARSAT 9
  Position Resolved: NIL
  Doppler A: 50°42.5N 005°04.9E Probability 85
  Doppler B: 65°24.7N 094°25.7E Probability 15

- Detection time: 1624 UTC by SARSAT 7
  Country of beacon registration 366/USA
  Serial Nr : 14645
  HEX Id : ADCC40E4D400261
  Psn resolved: 50°48.1N 005°13.0E
  Detection Freq : 406MHz

However, the ELT's registration "HEX Id: ADCC40E4D400261" originated still from the factory's initial encoding of the ELT and did not allow the RCC (Rescue Coordination Centre) to identify the airplane and its owner.

Note about Cospas-Sarsat:
The International Cospas-Sarsat Programme provides accurate, timely, and reliable distress alert and location data to help search and rescue authorities assist persons in distress.
The objective of the Cospas-Sarsat system is to reduce, as far as possible, delays in the provision of distress alerts to SAR services, and the time required to locate a distress and provide assistance, which have a direct impact on the probability of survival of the person in distress at sea or on land.
To achieve this objective, Cospas-Sarsat Participants implement, maintain, co-ordinate and operate a satellite system capable of detecting distress alert transmissions from radiobeacons that comply with Cospas-Sarsat specifications and performance standards, and of determining their position anywhere on the globe. The distress alert and location data is provided by Cospas-Sarsat to the responsible SAR services.

Note about the Beacon Registration Database:
Cospas-Sarsat implemented a new web interface for its International Beacon Registration Database (IBRD), effective June 2011. The IBRD website is a place where:
-beacon owners can directly register a beacon, when the beacon's country code corresponds to that of an Administration that allows registration on the IBRD ; and
-Search and rescue services can easily upload or retrieve beacon registration information.
The new IBRD accepts beacon registration by type (ELT, EPIRB, and PLB), as allowed by the national administration. If the national administration does not allow beacons with its country code to be directly registered by owners on the IBRD, then the owner must register the beacon in a database established by that country.

Fortunately, the RCC could determine that the emergency broadcasting came from the neighbouring EBST airfield and phoned to the airfield in order to verify if the alarm was an actual accident or not.

The take-off of the SAR (Search and Rescue) helicopter was cancelled upon the confirmation that no rescue action was necessary.

For information,

- The Belgian Royal Decree dated 9 January 2005 pertains to "The Technical Operation of General Aviation Airplanes" and specifies that ELT equipment must work according to the pertinent parts of ICAO Annex 10, Volume III.
- The Belgian CAA "Circulaire reference CIR/EQUIP-09" explains how to determine the specific code number of each ELT and how to register the ELT in a database in order to be able to identify an eventual ELT emergency broadcast signal.
  It has to be noted that this CIR/EQUIP-09 is theoretically only applicable to aircraft used in commercial air transport.
- AAIU(Be) made the following recommendation to the BCAA in the Accident Investigation Report OO-TRB dated 23 December 2010:

> *AAIU (Be) recommends the BCAA to prepare a change in the Belgian Regulation in order to comply with ICAO Annex 6 Part II "International General Aviation – Aeroplanes" Chapter 2.4.12 about the Emergency Locator Transmitters and to consider extending the requirements of carrying ELT's to national flights to improve the survival chances of injured persons in case of accident.*

Figure 17: ELT Switch installed on Dashboard.

1.16 Tests and research.

Not applicable

1.17 Organizational and management information.

BAFA Training School.

The Ben-Air Flight Academy is a Flight Training Organization approved by BCAA for compliance with the Royal 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 training organization plans training flights seven days a week. However, the training organization's management and some of the other staff that usually offer the necessary support to the instructors and student pilots during normal workdays are not present during the weekends.
The training organization principally makes use of freelance instructors. Some instructors are primarily planned during normal workdays only, while other instructors (as the instructor in this case) are primarily planned outside of normal workdays, during evenings and weekends, in order to maximize the potential for training progress of the student pilots and exploitation of the organization's fleet.

The Organization's procedures are defined in a series of Manuals:
FTO Quality Manual, FTO Operations Manual, FTO Training Manuals Etc …

BAFA Training Handbooks.

"VFR Training Handbook" covers the basic pilot skills and knowledge.
"MEP Training Handbook" intends to introduce multi-engine pilot skills and knowledge.

BAFA Operations Manual.

The operations manual of the Flight school contains a section on *"Flying duty period and flight time limitations"*.
The following limitation applies:

FI flight time will be a maximum of 06:00 within a 24:00 hrs/day period.

1.18 Additional information.

The Belgian Civil Aviation Authority delivers for each Belgian registered aircraft under 5700 kg MTOW a technical document called *"Certificate of Authorized Flights".*

The *"Certificate of Authorized Flights"* is unique to the aircraft considered and defines, from a technical point of view, the authorized activities and the meteorological conditions under which the aircraft may be operated.

Basically, the certificate is issued upon the technical equipment of the aircraft and therefore, the listing of required equipment for the different meteorological conditions (VFR, VFR Night, IFR, Icing Conditions etc) is attached at the back of the certificate.

The different equipment requested by BCAA for each type of activity is based on *"ICAO Annex 6 General Aviation paragraph 2"* and *"BCAA KB/AR dated 9 January 2005 - art 41"*. (Copies of these documents are enclosed at the end of this report).

Most of the *"Certificates of Authorized Flights"* are unlimited in time and remain valid as long as the airplane equipment is not altered. However, the "*IFR Certificate of Authorized Flights"* which is only valid for one year requests an assessment of the equipment to be annually performed.

Traditionally, the assessment of the IFR equipment of Belgian registered aircraft under 5700kgs MTOW is annually performed by a BCAA controller but no official information, specification or check list is available to support the assessment and also to allow this work to be performed by a maintenance organization.

The listing of required equipment requests, among other things, that an aircraft using a carburettor engine has to be equipped with a carburettor temperature indicator to fly IFR.

The airplane was granted an IFR *"Certificate of Authorized Flights"* although no carburettor temperature indicator was installed. The airplane was operated in VFR conditions when the crash occurred.

1.19 Useful or effective investigation techniques.

Not relevant

2 Analysis.

2.1 Possible causes of the runway excursion

The instructor pilot and the two student pilots on board declared after the crash that the flying student pilot had difficulties in short final to hold the airplane on the centreline of the runway.

Therefore, the instructor announced “I have the controls”, took over and landed the airplane.

During the landing roll, the instructor raised the flaps as preparation for the next take-off and at that moment, the rolling airplane turned violently to the left and became uncontrollable (while the other student pilot stated that the tendency to the left was already present, and aggravated when the instructor pilot retracted the flaps).
At that time, the engine throttles were in the following position:

- Engine 1: near the idle position (remained in “zero thrust”).
- Engine 2: retarded to idle.

During the interview with the investigators, both the instructor pilot and the two student pilots did not recall whether the instructor pilot transferred positively the control to the student or not.

Five possible reasons have been identified that could explain the tendency the airplane had to turn left and to leave the runway:

- A wrong setting of the rudder trim.
- A defect of the nose wheel steering system.
- A dissymmetry of flap position when retracting the flaps.
- An inappropriate input on the left brake pedal.
- An engine power and/or propeller trust dissymmetry between both engines.

At the end of the first inspection of the wreckage on the crash site, the Avidyne Multi-Function Display (MFD) and the Primary Flight Display (PFD) were removed in order to download the data of the last minutes of flight.

2.1.1 A wrong setting of the rudder trim.

As seen on the wreckage (See figure 10), the rudder trim position should have given the airplane the tendency to turn left.

The rudder trim barrel and shaft and the rudder trim rod were removed from OO-T** in order to compare the respective position of each part with a similar airplane.

All the parts positions and settings were measured and compared to a sister ship PIPER PA-44-180. It was demonstrated that the rudder trim of the airplane was approximately in neutral position when the crash occurred.

The reason why the rudder trim trailing edge was pointing toward the right was later found to be due to the deformation and displacement of the lower rudder hinge of the rudder.

2.1.2 A defect of the nose wheel steering system.

As seen on the following picture the nose wheel steering linkage suffered significant damage when the nose wheel section of the fuselage was severed.

Both broken rod ends have been thoroughly examined in order to determine the type of load that caused the rupture and it could be demonstrated that both fractures were static failures caused by the crash.

The study of mechanical linkage showed a loose safety nut at the bearing rod end located between the steering cam and the nose wheel bungee. However, this could only induce a modification of the rod length involving a possible dissymmetrical position of the rudder pedals when the nose wheel was in neutral position. No pilot reported a dissymmetrical position of the rudder pedals.

The fixation rivets of the rib supporting the nose wheel steering bell-crank were also examined. All of them were pulled out under abnormal static load. There was no trace of fatigue breakage or excessive wear of the rivets.

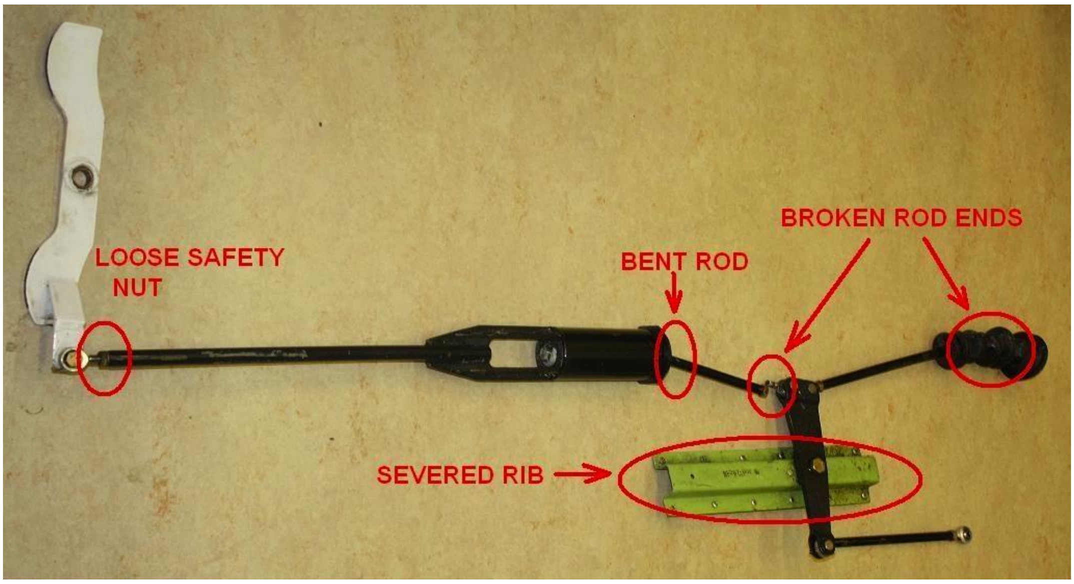


Figure 18: Nose wheel steering linkage

All the parts of the nose wheel landing gear were thoroughly examined as per maintenance manual. Among other things, the “Bungee assembly” and the “Nose Gear Centering” were disassembled, inspected and found in good condition.

The Maintenance Manual, troubleshooting section, was also used as a guideline. (This guideline is enclosed at the end of this report)

No anomalies were found except for the loose safety nut mentioned above.

Taking into account that:

- No pre impact mechanical breakage was found;
- The loose safety nut had no (or did not yet have) influence on the setting of the bungee assembly of the steering system;

- The instructor, who was involved in the accident, did not find anything wrong with the steering system during the pre-flight inspection and the first taxi of the day;
- The airplane continued to turn left after having taken off, when obviously the nose wheel steering doesn't control the airplane in flight;

It is likely that the steering system was in good condition.

<u>Note about the observation by some pilots of steering problems</u>: To steer an airplane, pilots regularly use a combination of the steering system and a dissymmetrical brake action, sometimes unconsciously. Therefore, the possibility does exist that the difficulties encountered by some pilots to steer the airplane were due to the less efficient new brake disks (Not yet run in).

2.1.3 A dissymmetry of flap position when retracting the flaps

Impact traces of the flaps on both fuselage flanges showed that both flaps were fully retracted when the accident occurred. No anomaly was found.

However, extending the flaps moves the center of lift rearward, inducing a pitch down force increasing the effective weight on the nose wheel.
Retracting the flaps has the opposite effect, thus reducing the efficiency of the nose wheel steering. This phenomenon could explain why the pilot was not able to compensate a yaw dissymmetry when he retracted the flaps when rolling on the runway."

2.1.4 An inappropriate input on the left brake pedal.

Neither of both pilots reported they used the brakes after the touch down nor was there any reason to do so.

Moreover, the pilot trying to avoid the left hand runway excursion would have pushed on the right hand rudder pedal only and possibly meanwhile on the R/H brake pedal, but not on the L/H brake pedal.

It is very unlikely that an inappropriate use of the brakes could be the cause of the accident.

2.1.5 An engine power trust dissymmetry.

Both the Multi-Function Display (MFD) and the Primary Flight Display (PFD) were removed from the wreckage after the crash.

The MFD recording more information about the engine operation than the PFD was first sent to a specialized company in order to download the records. The MFD was downloaded, the data covering the last 47 minutes of the flight. However, due to the buffering during data acquisition it was also necessary to download the PFD to recover the last 30 seconds of the flight.

The last data of the PFD were synchronized and added to those of the MFD in order to reconstruct the entire flight data. However, the last EGT's data which are not recorded by the PFD were missing.

The last GPS position recorded was close to the final position of the wreckage.

Based on the aforementioned data, the following graphs show the six last minutes of the flight beginning at 15:54:54 at the end of the previous touch and go and ending when the airplane battery was severed during the crash.

TIME	OBSERVATIONS	PROBABLE ACTION
15:54:54	• MAP, RPM, Fuel Flow and EGT move accordingly.	Throttles of both engines fully retarded ⇨ Previous Landing
15:55:06	• MAP, RPM, Fuel Flow and EGT move accordingly.	Throttles of both engines moved forward ⇨ Take Off
15:55:42 - 15:56:30	• MAP of both engines decreases down to L/H: 17,9” Hg and R/H: 18,9” Hg. • **L/H Fuel Flow decreases a little more than R/H at 15:56:24.** • RPM of both engines reduced progressively from 2500 to 2350 RPM	Throttles of both engines progressively moved rearward ⇨ Levelling off
15:56:30 – 15:56:42	• MAP, RPM, Fuel Flow and EGT are stable showing the L/H fuel flow to be lower than R/H.	No movement of the throttles.
15:56:48 – 15:57:00	• **Fuel Flow of L/H engine decreases significantly.** • **EGT L/H increases first slightly and then drops significantly.**	⇨ **Fuel system anomaly.** **or** ⇨ **Fuel shut off valve closed by instructor.** (In this case, this would indicate the start of one engine inoperative simulation)

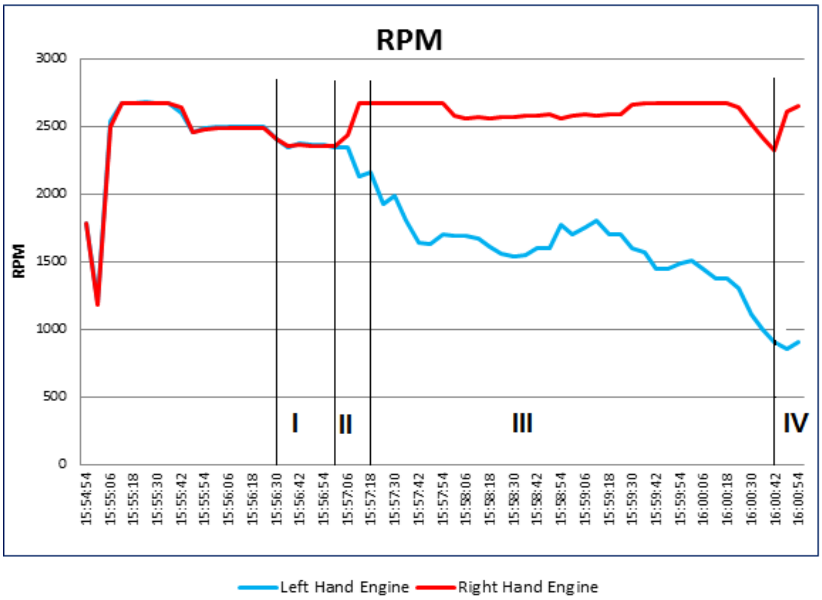
15:57:06 - 15:57:18	• MAP of both engines increases up to full throttle • RPM of R/H engine increases up to 2670 RPM • **RPM of L/H engine decreases from 2340 to 2130 RPM** • Fuel flow R/H engine increases up to 14,2 Gal/h • **Fuel Flow L/H engine decreases down to 2,4 Gal/h** • R/H EGT indicates around 1400° • **EGT L/H engine decreases significantly and finally indicates 0° at 15:57:18**	Throttles of both engines moved fully forward (Probably to determine which engine is inoperative (Dead foot side = dead engine side)
15:57:24 - 15:58:48	• **EGT of L/H engine stays on 0° while R/H engine stays around 1340°.** • **MAP of L/H engine decreases first drastically from 26,9 " to 7,2" and then at 15:58:18 increases progressively up to 12,4.** • MAP of R/H engine stays around 27,8" Hg • RPM of L/H engine decreases progressively from 1920 to 1600 RPM. **No increase of RPM when MAP is increased to 12,4" Hg**. R/H engine RPM varies between 2560 and 2670. • **Fuel Flow L/H engine fluctuates between 2,6 Gal/h and 0 Gal/h** • R/H fuel Flow stays around 14,0 Gal/h.	⇨ **L/H engine throttle moved fully rearward (while R/H engine throttle stays fully forward).** ⇨ **Thereafter, at 15:58:24 MAP of L/H engine increased to 12,4" Hg = attempt to set the propeller RPM to approximate zero thrust (to simulate propeller feathering).**

15:58:54 - 15:59:18	• **EGT of L/H engine stays on 0°** while R/H engine varies between 1349° and 1321°. • MAP of L/H engine stays around 13,2" Hg while R/H engine MAP decreases up to 18,6" Hg. • RPM L/H engine fluctuates around 1750 RPM while R/H engine RPM stays around 2580 RPM. • **Fuel Flow L/H engine fluctuates between 0 and 2,2 Gal/h** while R/H fuel flow decreases from 13 to 8,4 Gal/h	R/H engine throttle retarded. ⇨ A/C in final leg.
15:59:24 - 16:00:12 (Last MFD data)	• **EGT of L/H engine stays on 0° while R/H engine varies between 1342° and 1398°.** • MAP of L/H engine varies from 11,5 to 13,9" Hg while R/H engine MAP increases from 26,2 to 27,1" Hg. • RPM L/H engine decreases from 1700 to 1370 RPM while R/H engine RPM increases rapidly from 2590 to 2670 and stays at 2670 RPM	R/H engine throttle moved slightly forward. ⇨ Power adjustment.

16:00:18 **End of MFD Data =>** **PFD data only =>** **No EGT data available**

16:00:30 - 16:00:42	• RPM L/H engine decreases from 1100 to 900 RPM while L/H engine decreases from 2520 to 2320 RPM. • MAP L/H engine increases from 16,5 to 19,6" Hg due to RPM decreasing, while R/H engine decreases from 19,3 to 16,5" Hg • Fuel Flow L/H engine stays on 0 while R/H engine decreases from 11,5 to 7,9 Gal/h	R/H throttle reduced ⇨ Landing

16:00:48 - 16:00:54	• MAP of both engines increases to full throttle (L/H: 29,5” Hg and R/H: 28,6” Hg). • RPM of R/H engine increases to 2650 RPM while L/H stays on 900 RPM • Fuel Flow of R/H engine increases to 13,9 Gal/h while L/H increases very slightly to 0,7 Gal/h.	Both throttles fully opened. ⇨ Applying both engines full throttle for Take Off. ⇨ No reaction of L/H engine
16:00:54	• Last PFD data recorded	
Between 16:00:54 – 16:01:00	• Electrical energy of the PFD is interrupted	Airplane battery is severed during the crash.

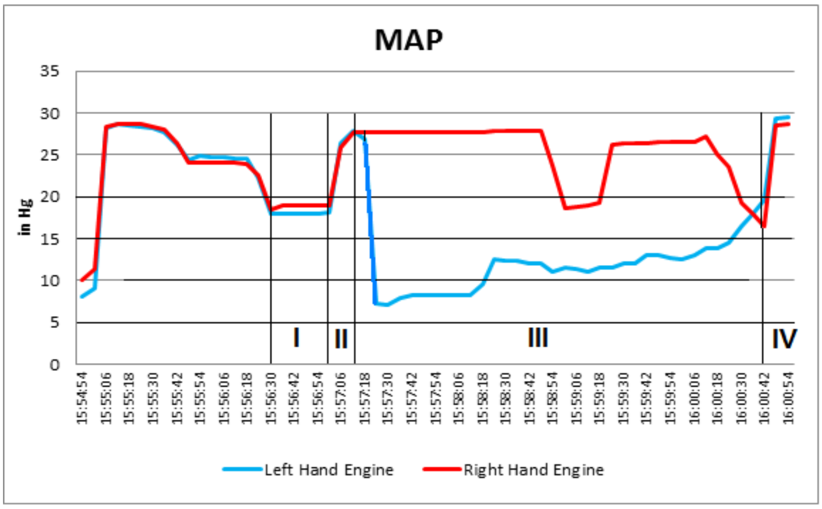


I: Both Engines Reduced

II: Both Engines Full Throttle LH Engine RPM decreases

III: Gradual reduction of LH Engine RPM

IV: Both throttle in TO; no reaction from LH Engine.

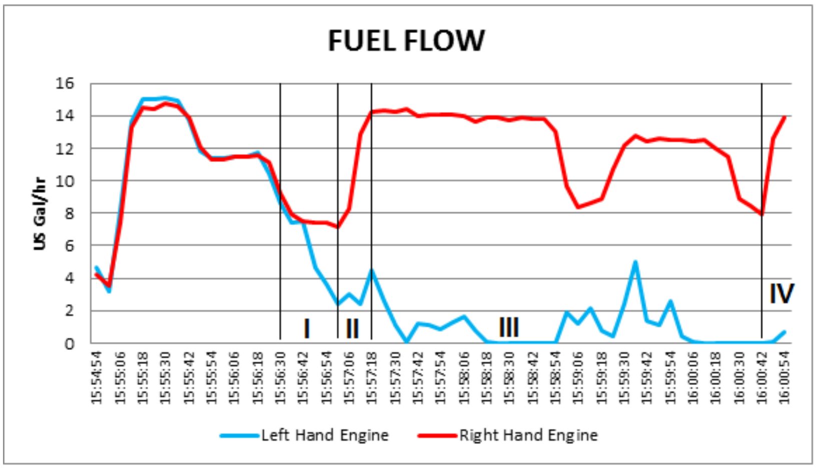


I: Both Engines reduced

II: Both Engines Full Throttle

III: 1 Eng out Exercice - LH Throttle reduced

IV: After landing, both engine throttle in TO.



I: Both Engines reduced

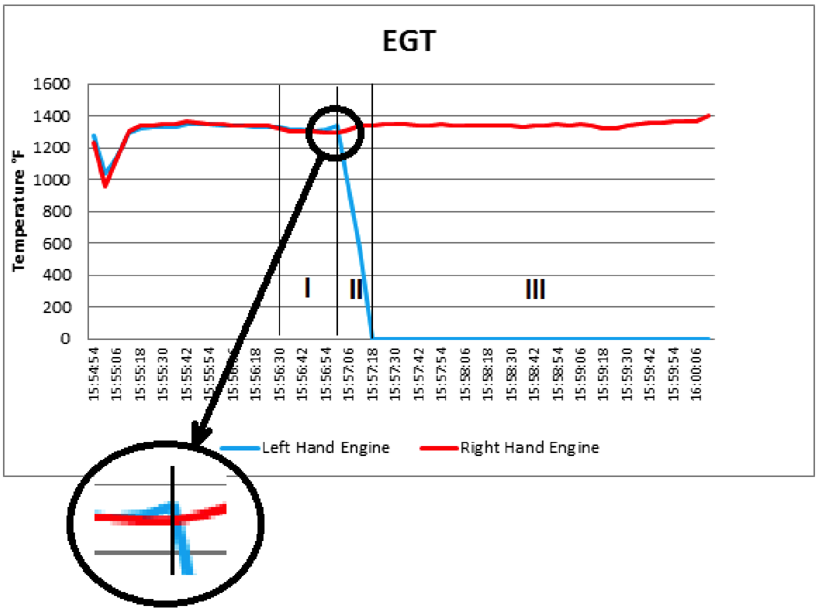
LH Eng. FF drops after a few seconds.
(Note : Idle FF is 2.5 USG/hr)

II: Both Engines full throttle

LH Eng. FF is increasing slowly.

III: LH Eng. FF erratic - drastically low

IV: LH Eng. FF remains low, while full throttle is applied.



I: Both Engines reduced

LH Eng. EGT rises shortly (too lean mixture).

II: LH Eng EGT drops (towards 0)

No more combustion in LH engine.

III: LH Engine not operating.

The preceding graphs and table show a few interesting engine parameters during different phases of the flight, such as:

- 15:56:30: both engine throttle reduction = preparation of one engine inoperative exercise.
- 15:56:48: significant decrease of the fuel flow of the L/H engine = fuel system anomaly or shutting off of fuel selector valve.
- 15:57:06 to 15:57:18: both engines throttles were pushed forward while L/H engine RPM drops from 2340 to 2130 (L/H engine had stopped operating) = The pilot is determining which engine had stopped operating (Dead foot = dead engine).
- 15:57:18: Fuel flow increased up to 4,5 Gal/h = limited jump of fuel flow = probable carburettor bowl filling (Note: the filling of an empty carburettor bowl being performed within a few seconds and the frequency of recording being every 6 seconds can explain why the fuel flow indication is limited to 4,5 Gal/h).
- 15:57:24: L/H engine throttle closed (7,2" Hg MAP).

- 15:57:30: An extremely low and erratic fuel flow up to the last PFD data at 16:00:54.

Obviously, the L/H engine fuel flow was less than normal from 15:56:48 up to the crash and was erratic and drastically low.

The fuel consumption of the L/H engine, for a given value of the Manifold Air Pressure and the RPM was so low that the air/fuel ratio was not flammable anymore.

The L/H engine had virtually stopped operating from 15:56:48 up to the crash 4 minutes later.

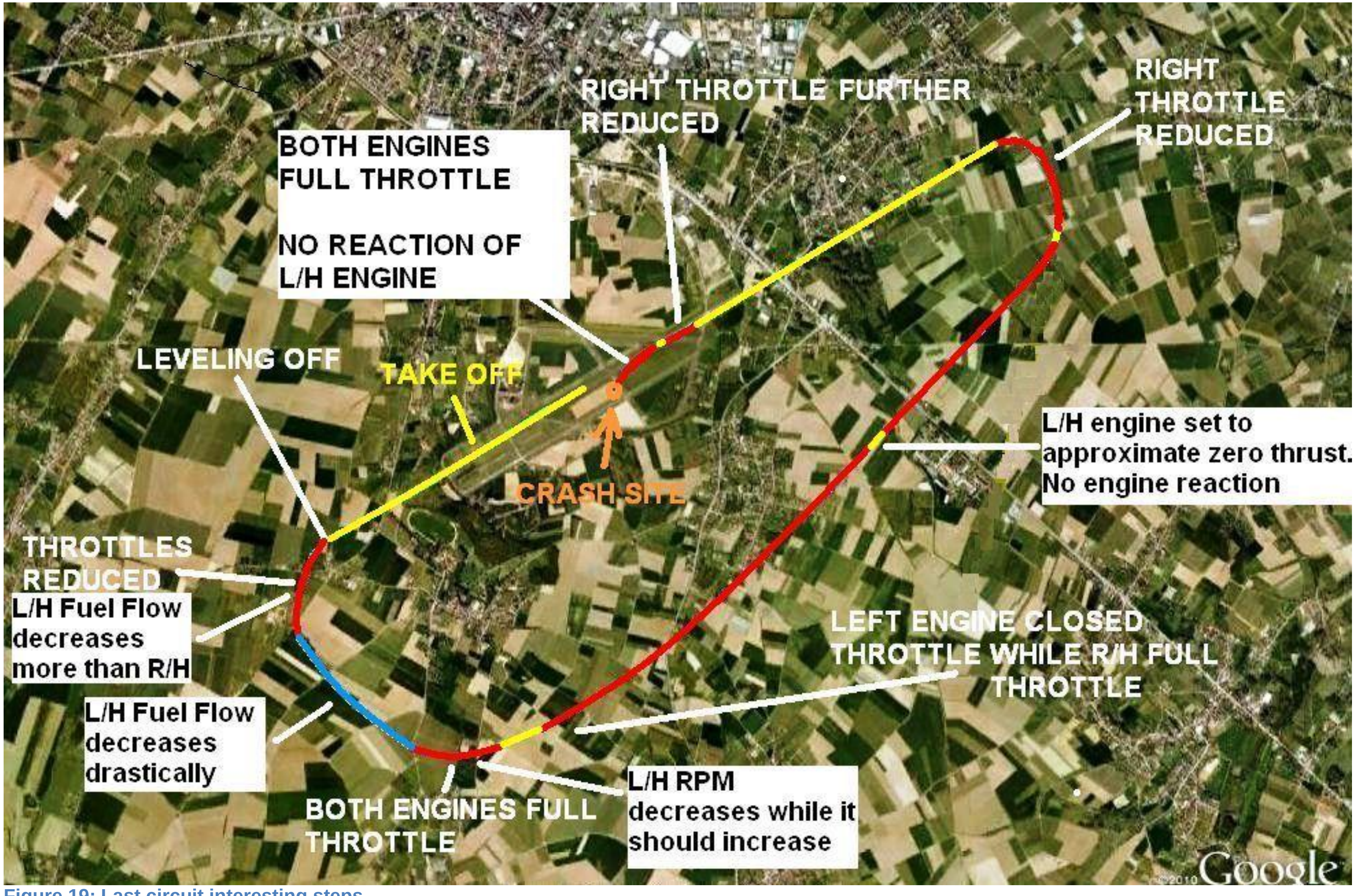


Figure 19: Last circuit interesting steps

2.2 Engine failure analysis.

The engine controls were significantly damaged during the crash. However, the MFD and PFD engine MAP parameters showed that the throttle controls of both engines worked correctly up to the end of the flight.

The airplane's occupants remember that the mixture control of both engines remained in the full rich position.

It was demonstrated there was enough fuel on board to properly feed both engines.

As the fuel flow of the L/H engine dropped significantly within a very short period of time, the airplane fuel system and the L/H engine were thoroughly inspected.
The fuel filters, the carburetor and the mechanical fuel pump of the L/H engine were thoroughly inspected. In particular, the carburetor was completely dismantled and examined in order to find any contamination or sign of anomaly. No pre impact fuel leak and no anomaly in the airplane's fuel system were found.

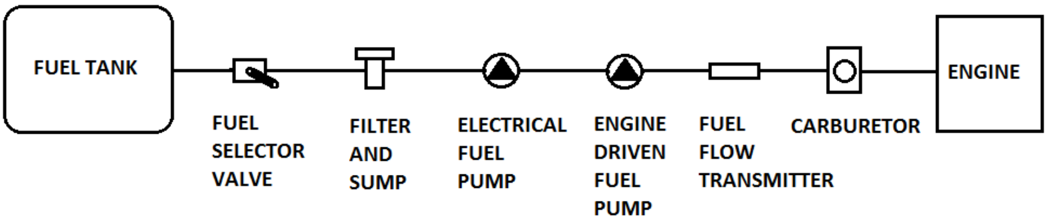


Figure 20: Schematic fuel circuit for one engine (Note: Entire fuel system schematic on Figure 21).

As no technical anomaly was found, possible operational problems were considered.

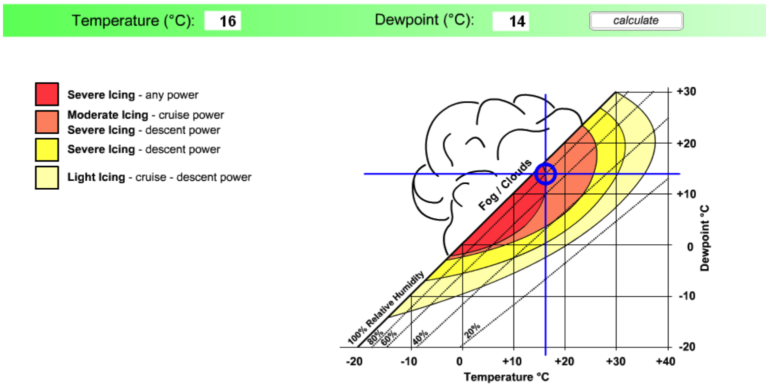
Therefore, carburetor icing and/or inadequate setting of the fuel selector valve were investigated.

The instructor stated that the fuel selector valve remained in the open position during the last circuit but his recollection of the last minutes of flight could have been somewhat altered by the chock of the accident. Additionally, the students stated that simulations of engine failure had been done during the different exercises of this day, alternatively by retarding the throttle or by shutting off the fuel selector valve to make the exercise more realistic.

Consequently, the possibility the fuel selector valve was shut off by the instructor to initiate the engine failure simulation does exist.

Finally, two hypotheses could explain why the engine stopped operating:

- A carburetor icing beginning after leveling off the airplane and reducing the throttle to around 18" Hg MAP.
- A shutting off of the fuel selector valve and reopening of the valve by the instructor around 30 seconds later, immediately followed by a carburetor icing when the throttle is reduced to idle position by the student pilot for the rest of the exercise.



The risk of carburettor icing is related to the air temperature and relative humidity. By the input of these values, you can estimate the approximate probability of carburettor icing by means of the diagram.

Figure 22: Probability of carburettor icing

As seen on the above figure, the airplane was flying on this day on the border between:

- *"**Severe Icing** in any power" and;*
- *"**Moderate Icing** in cruise power and **Severe Icing** in descent power"*

In flight, the temperature decreases due to the altitude and the relative humidity increases, moving towards "Severe Icing" in any power. Obviously, the meteorological conditions were likely to induce carburettor icing, particularly in descent power.

Between 15:56:24 and 15:56:42, the throttle positions (MAP) of both engines were reduced down to 17,9" Hg, with some fluctuations for the L/H engine, and a stable 18,9" Hg for the R/H engine.
It is precisely during this period of time that the fuel flow of the L/H engine began to decrease.

It is possible that a carburettor icing phenomenon started in this phase of the flight, between 15:56:24 and 15:57:00 because:

- The L/H engine throttle was slightly more closed than the R/H.
- The L/H engine MAP fluctuated slightly as if the engine was running roughly.

Later, from 15:57:24 to the end of the flight, it is likely that carburettor icing occurred due to the closed throttle, the engine wind milling and the meteorological condition (air temperature and relative humidity).

2.3 Equipment to prevent carburettor icing.

The engines are fitted with a hot/cold air intake control. Usually, the carburettor heater system is used by the pilot during typical phases of the flight such as during the landing circuit or when the pilot suspects a risk of carburettor icing.

However, it is not always easy for the pilot to anticipate and to detect the carburettor icing phenomenon.

Therefore, most of the airplane manufacturers propose the installation of optional instruments intended to warn the pilots when carburettor icing occurs or is likely to occur.

The most common instrument is the carburettor temperature indicator. Other devices do also exist such as carburettor ice detector...

BCAA requires that all Belgian registered airplanes performing IFR/IMC flights are fitted with a carburettor temperature indicator (See § 1.18 for more details).
The airplane was approved for IFR flights, nevertheless it was not fitted with such equipment.

Note:

- The crash at EBST occurred during a VFR/VMC flight for which a carburettor temperature indicator was not compulsory.
  However, it would have been helpful for the pilots to assess the carburettor temperature during the one engine inoperative simulation.
- Moreover, a carburettor temperature indicator would be very helpful to sensitize young pilots to the phenomenon of carburettor icing.

2.4 Crew actions during the simulated engine failure.

The training procedure for the simulation of one engine inoperative should be as close as possible to an actual engine failure situation. In any case, the procedure must ensure the simulated failed engine remains operative.

After the take-off, when levelling off, the pilot reduced both throttles, prior to the inoperative engine simulation. Thirty six seconds thereafter, at 15:56:18, the fuel flow of the L/H engine began to decrease drastically, possibly due to closing the shut off valve or due to a carburettor icing phenomenon.

The interview of the crew could not positively determine if the carburettor heat of one or both engines was set to ON at that moment.

Before setting the L/H engine to idle, at 15:57:06, full power was applied to both engines when turning to downwind. Apparently, the pilot applied full power as per the procedure in case of engine failure to determine with certainty which engine failed (dead foot = dead engine).

A few seconds later, at 15:58:18, after having determined that L/H engine was inoperative and setting the throttle to idle, the pilot slightly increased the MAP of the L/H engine, probably to simulate a zero thrust setting equivalent to a feathered propeller. The MFD data show that the engine did not respond to this (limited) opening of the throttle.

After the landing, the airplane rolling on the runway turned to the left when the instructor pilot was retracting the flaps. It was probably due to:

- The drag of the L/H failed engine
- The low speed, rendering the rudder less effective.
- The forward displacement of the center of pressure when retracting the flaps that reduced the pitching-down moment and thus the apparent weight of the nose wheel and therefore the steering efficiency.

By pushing both engine throttles fully forward and lifting off the airplane, the engine power dissymmetry was made worse at or under VMCA speed and the accident was unavoidable.

2.5 Position of the airplane when the loss of control occurred.

As seen on the following picture, the touch down was performed around 260 m beyond the threshold and the increasing of the throttles to full power was done around 460 m after the passage above the threshold.

That means that 740 m runway was still available in front of the airplane when full power was applied. At this moment, there was sufficient time available to slowly increase the power of both engines in order to assess their response.

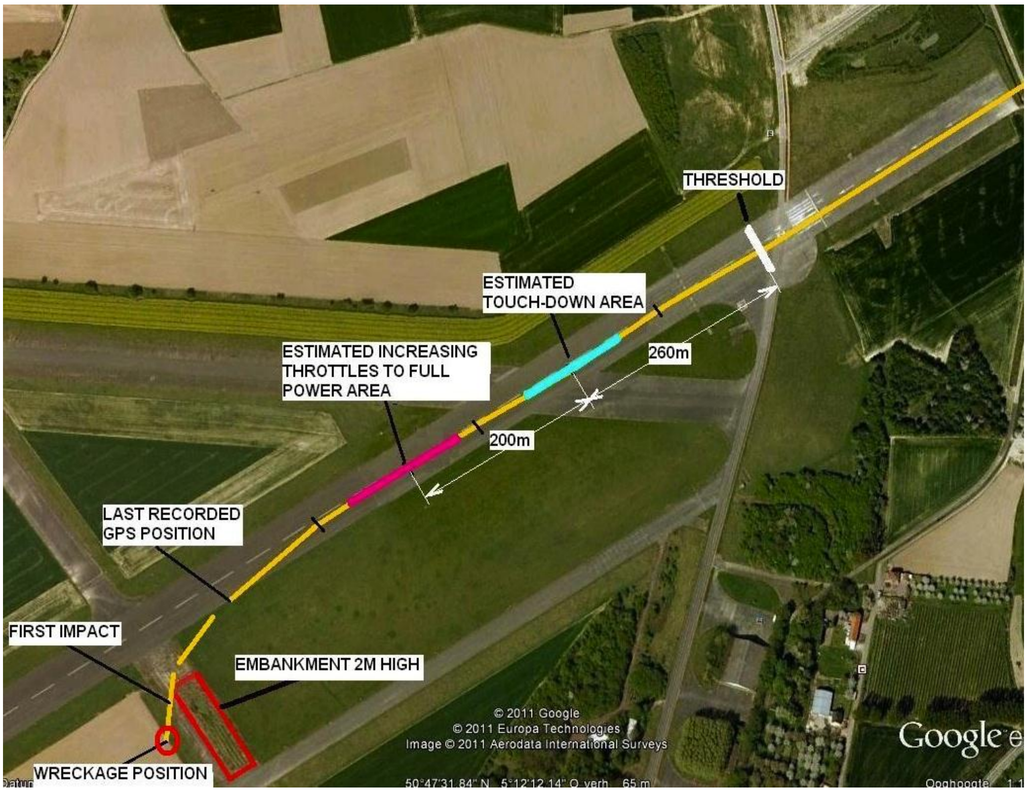


Figure 23: Estimated touch down area and full power setting area

2.6 Flight School Guidance material

In a practical way, an inoperative engine simulation involves more workload for the crew than an actual engine failure. Indeed, the simulated inoperative engine must be properly managed and assessed during the entire training procedure to ensure it remains operational.

With respect to engine failure, the “VFR Training Handbook” outlines the differences between a real engine failure and a simulated engine failure.
Moreover, this part of the handbook also warns the pilots against the danger of inducing an actual engine failure during a simulated engine failure exercise.

By contrast, the “MEP Training Handbook” does not contain the same information pertaining to the one engine inoperative simulation.

The lack of information and guidance in the MEP training handbook about how to assess and prevent a simulated inoperative engine to actually break down could have prevented both pilots and the observer to adequately realize that the L/H engine was no longer operating.

For example, the flight school procedure for “One Inoperative Engine Landing” requests the carburettor heater of the working engine to be set ON when turning Base leg and set OFF in short final.
But no additional instruction or information is available about the use of the carburettor heater of the simulated inoperative engine.

The flight school procedure for “One Inoperative Engine Landing” doesn’t mention the possibility to actually stop the operation of the engine by shutting off the fuel selector valve while it is known that this type of exercise is regularly practiced in a lot of flight schools. No clear information was found in the flight school stating that shutting off the fuel selector is allowed or not to simulate engine failures.
In the case it is allowed it would be helpful for student pilot and instructors to be provided with a complete procedure to do that properly. Otherwise, it would be clearly stated that engine failure simulation by shutting off the fuel selector valve is not allowed.

Additionally, the “MEP Training Handbook” describes a typical multi-engine airplane as being (systematically) equipped with fuel-injected engines instead of carburetted engines. The handbook mentions among other things:

> *“Be familiar with the aircraft system and equipment, specific to multi-engine aircraft.”*

> *Rather than having a carburettor installed, fuel injection offers a more precise and efficient way of feeding fuel to the engine.*
>
> *… “This means that that the problem of carburettor icing is removed as well.” …*

Each pilot should be familiar with the type of aircraft he flies. However, the above information could have reduced the crew awareness about carburettor icing.

2.7 Emergency Locator Transmitter working.

The emergency was transmitted to the Belgian RCC by SARSAT Toulouse but, as mentioned in § 1.15, the identification of the aircraft type, registration and owner references was impossible due to inadequate ELT encoding.

Normally, the correct encoding of an ELT and its registration in the BCAA database includes, among other things, the references and phone number of the aircraft owner (or another contact person). This is done in order to allow RCC to evaluate the extent of the emergency (due to the type of airplane) and to contact the aircraft owner and determine if the ELT broadcasting would correspond to an actual emergency or not.

The absence of correct encoding and registration of the ELT did not allow RCC to contact the owner.

2.8 Human factors.

2.8.1 The apprehension for a potential nose wheel steering problem.

The instructor pilot, shocked by the crash, did not remember the last seconds of the flight. However, he did recall seeing the airplane violently turning to the left, heading directly towards the embankment.
Taking into account that he was aware of a potential nose wheel steering problem, primed by the trouble reports, it was then logical that he immediately deduced that a nose wheel steering failure had occurred.
From that moment, in his mind, the only way to avoid a runway excursion was to take-off as soon as possible.

2.8.2 The instructor pilot vigilance.

The instructor had a relatively low total experience on twin-engine airplanes (60h) and his 25 hours experience as instructor on multi-engine piston airplanes was very low.
The day of the accident he returned to office after 21 days leave in order to perform around 6 hours of instructional flights. Before starting the first flight of the day, the instructor pilot and the first student pilot encountered some difficulties to refuel the airplane due to problems with the fuel card, which first was missing and then was found unserviceable. They spent an hour and a half at EBAW airport to prepare the flight and refuel the airplane.
When the accident occurred at 16:00 UTC, the instructor pilot had already been occupied for 8 hours and a half (since 7:30 UTC) and had already given 5 hours of instructional flights, close to the maximum of 06:00 within a 24:00 hrs/day period mentioned in the flight school operations manual.
When prior permission for the concerned training flights was requested from the EBST airfield operator, the student pilot making the request by telephone was informed by the EBST airfield commander that recently there had been many complaints about previous BAFA training flights not adhering to the traffic circuit noise abatement procedures (avoiding the neighbouring residential areas), which today therefore would be closely monitored. This aggravated the workload of the instructor pilot, as neither of both student pilots was thoroughly familiar with EBST airfield and its unpublished circuits, since the majority of their training normally takes place at EBAW airport, which has published circuits.
The meteorological conditions were acceptable but not very favourable for the concerned instructional flight, showing good visibility outside regular rain showers. On the other hand, the traffic flying around EBST on this day (Sunday) required particular attention, as for example the airplane suffered a near mid-air collision while in the traffic circuit less than one hour before the crash.
All of the above parameters, such as low experience, 21 days without flying, student pilots unfamiliar with the uncontrolled airfield traffic circuit noise abatement, meteorological conditions, and particular attention required due to the “Sunday” traffic and the 5 hours (and more …) of instructional flights were factors inevitably conducive to the cognitive fatigue of the instructor pilot.

2.8.3 Cockpit resource management.

In short final, the instructor announced “I have the controls”, took over and landed the airplane.
No indication was found during the investigation that could show the student pilot took over when the airplane was rolling on the runway.
No occupant of the airplane remembered after the crash having heard a positive transfer of the controls during the landing roll.

3 Conclusions.

3.1 Findings.

- The airplane was in airworthy condition.
- The instructor pilot and the student pilot were qualified for the flight.
- No technical condition was found on the airplane to explain a pre-impact failure of the engine.
- The left hand engine stopped working around 4 minutes before impact.
- The meteorological conditions were conducive to carburettor icing.
- The carburettor heat system of the L/H engine likely seems not to have been used during the simulation of L/H inoperative engine.
- The crew did not realise that the simulated inoperative engine became actually inoperative.
- There was no carburettor temperature indicator installed in the airplane.
- The Emergency Locator Transmitter was not properly encoded.

3.2 Causes.

The cause of the accident is a loss of control during a touch and go performed with an undetected inoperative engine.
The left hand simulated inoperative engine probably became inoperative due to carburettor icing.

<u>Contributing factors</u>

- The meteorological conditions were conducive to carburettor icing.
- No equipment was installed in the airplane to help the crew to detect carburettor icing.
- The apprehension of a potential nose wheel steering problem led the instructor pilot to think that the airplane turned uncontrollably on the ground due to a nose wheel steering failure. Therefore, for the pilot, the airplane had to be lifted off as soon as possible.
- The possible cognitive fatigue of the instructor pilot after 5 hours of instructional flights, due to the combination of several unfavourable factors, may have reduced his awareness capacities. Some of these unfavourable factors could be directly related to the training organization. In particular, some of the organization's support staff is not present during weekends, making simple procedures such as locating a fuel card an unnecessarily time-consuming exercise.
- The “MEP Training Handbook” used for multi-engine training does not inform and/or warn the student and instructor pilots against the danger of engine failure during the one inoperative engine simulation (While the “VFR Handbook” does incorporate useful information for the simulated forced landing exercise with single engine airplanes).

4 Safety recommendations.

Recommendation 2012-P-3 to BCAA concerning the maximum "*Flying duty period and flight time limitations*".
AAIU(be) recommends the BCAA to request the Flight Training Organizations to update their Operations Manual in order to adequately balance the maximum allowed flight training hours towards the specificities of the many different instructors used. For example senior instructors versus less experimented instructor pilots, instructor pilots coming back from a holiday leave, sick leave or duty at other companies … etc.

Recommendation 2012-P-4 to BAFA flight school concerning the *"MEP Training Manual"*

- AAIU(be) recommends the flight school to modify the Chapter 2.1 of "MEP Training Manual" in order to clearly inform the student pilot that the twin engine airplanes are not systematically equipped with fuel injected engine and particularly, the PIPER PA-44-180 used in the flight school are equipped with carburetted engines, and therefore subject to carburettor icing.
- AAIU(be) recommends the flight school to establish a procedure in order to avoid a simulated inoperative engine becoming actually (and undetected) inoperative.

Recommendation 2012-P-5 to BCAA concerning the installation of carburettor temperature indicators in the IFR approved aircraft.
AAIU(be) recommends BCAA to ensure the presence of carburettor temperature indicator as required in BCAA listing of IFR equipment.
Action: On 24 August 2012, BCAA (Private Aviation Authority) revised the "Airworthiness Review Checklist" to add the verification of the presence of a carburetor temperature indicator in the IFR approved aircraft.
Status: Accepted and closed.

Recommendation 2012-P-6 to BCAA concerning the installation of carburettor temperature indicator in the VFR training approved aircraft.
AAIU(be) recommends BCAA to consider the installation of carburettor temperature indicators in all the VFR training airplanes used in Belgium in order to sensitize student pilots to the danger of carburettor icing.

Recommendation 2012-P-7 to BCAA concerning the encoding of ELT's.
AAIU(be) recommends BCAA to wage a campaign of information concerning the correct encoding of ELT'S.
Action: On 03 August 2012, BCAA (Private Aviation Authority) sent an information letter to all non-commercial aircraft owners.
Status: Accepted and closed.

Recommendation 2012-P-8 to BCAA concerning the ELT's regulation.
AAIU(be) recommends BCAA to prepare a change in the Belgian Regulation in order to comply with ICAO Annex 6 Part II "International General Aviation – Aeroplanes" Chapter 2.4.12 about the Emergency Locator Transmitters and to consider extending the requirements of carrying ELT's to national flights. (Note: this recommendation is a recall of a recommendation made in the Accident Investigation Report OO-TRB dated 23 December 2010)

Recommendation 2012-P-12 to BCAA concerning the assessment of IFR equipment.
AAIU(be) recommends that the BCAA publish official information, specification or check list to support the annual assessment of the IFR equipment of Belgian registered aircraft under 5700 kg MTOW and also to authorize this work to be prepared and/or performed by an approved maintenance organization.

5 Enclosures

5.1 METAR's EBBR and EBLG

METAR EBBR

METAR EBBR 111520Z 20007KT 170V230 9999 SCT012 BKN020TCU 17/15 Q1009 TEMPO 21015G25KT 4500M SHRA=
CCA METAR COR EBBR 111520Z 20007KT 170V230 9999 SCT012 BKN020TCU 17/15 Q1009 TEMPO 4500M SHRA=
METAR EBBR 111550Z 22013KT 6000 SHRA FEW012 SCT018TCU BKN031 16/14 Q1009 TEMPO 4500M SHRA=
CCA METAR COR EBBR 111550Z 22013KT 6000 SHRA FEW012 SCT018TCU BKN031 16/14 Q1009 TEMPO 4500M SHRA=
METAR EBBR 111620Z 22011KT 9999 SCT019 SCT042 16/14 Q1009 RESHRA TEMPO 4000M SHRA=
CCA METAR COR EBBR 111620Z 22011KT 9999 SCT019 SCT042 16/14 Q1009 RESHRA TEMPO 4000 SHRA=
METAR EBBR 111650Z 22009KT 9000 -SHRA SCT013 BKN033 16/14 Q1009 TEMPO 4000 SHRA=
METAR EBBR 111720Z 23008KT 9999 -RA FEW013 SCT040 15/14 Q1009 TEMPO 4000 SHRA=
METAR EBBR 111750Z 21009KT 9999 RA NSC 14/13 Q1009 TEMPO 4000 SHRA=

METAR EBLG

METAR EBLG 111520Z 20009KT 9999 SCT027 BKN040 17/14 Q1009 TEMPO 5000 SHRA=
METAR EBLG 111550Z 20011KT 9999 -SHRA SCT019 BKN041 17/15 Q1009 TEMPO 5000 SHRA=
METAR EBLG 111620Z 21018KT 170V230 4400 -SHRA SCT006 BKN015 16/14 Q1010 TEMPO 3500 SHRA BKN005=
METAR EBLG 111650Z 21012KT 9999 -SHRA FEW005 SCT017 BKN038 16/14 Q1010 TEMPO 3500 SHRA BKN005=
METAR EBLG 111720Z 22015KT 9999 -SHRA FEW005 BKN017 BKN038 16/14 Q1010 TEMPO 3500 SHRA BKN005=
METAR EBLG 111750Z 22012KT 9999 FEW005 SCT017 BKN030 16/14 Q1010 NOSIG=

5.2 Description of the Data Recording Capabilities and rate of the PFD.

The PFD samples and stores several data streams in a sequential fashion.

The specific parameters recorded by the PFD include:

AHRS Data "Attitude and Heading Reference System" (5 Hz)
Pitch attitude
Roll attitude
Heading
Pitch rate
Roll rate
Yaw rate
Vertical acceleration
Longitudinal acceleration
Lateral acceleration
Air Data Information (1 Hz)
Pressure altitude
Vertical speed
Indicated airspeed
True airspeed
Total temperature
Navigation data (0.25 Hz)
Selected nav. source (GPS or VHF)
Tuned VHF nav. frequency
Next GPS waypoint ID and distance
Active course
Horizontal and vertical deviations
GPS lat/long
GPS groundspeed
UTC date and time
Note: information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.
Engine data (each engine, 1/6 Hz)
Percent power
Manifold pressure
RPM
Fuel flow
Oil temperature
Oil pressure
Pilot settings (event driven)
Altimeter setting
Bugs (altitude, heading, vertical speed)
Map format and range

5.3 Last Release to Service (500h Inspection)

Winters Aviation — **Aircraft certificate of release to service and maintenance statement**

Approval Ref. n° BE.145.28	Form WA-24	Revision Date. 01/10/2007

Work order: 4358/11	Registration:	Customer: BAFA	Date in : 31-aug-11 Hobbs : 1493,3
Location where check was completed: EBAW Antwerp airport B-2100 Deurne Antwerpen		Heater : 172.45 Flight time: 1121:06	Date out : 07-sep-11 Hobbs : 1493,5
AMP/OO-TMS/Revison 01	Date: 4/3/2010	Work type: 100H	
Manual reference: Piper MM 761-892 (PR091231)			

	Type	Serial number	time since new	Time SOH
Aircraft :	Piper PA 44-180	4496268	1493:18	/
Eng. LH:	Lycoming O-360-A1H6	L-41453-36E	1493:18	/
Eng. RH:	Lycoming LO-360-A1H6	L-907-71E	1493:18	/
Prop. LH :	Hartzell HC-C2YR-2CEUF	AU13826B	1493:18	/
Prop. RH :	Hartzell HC-C2YR-2CLEUF	AU13771B	1493:18	/

Engine cylinders compression test: Document ref: SI1191A

#1LH	#2LH	#3LH	#4LH		#1RH	#2RH	#3RH	#4RH
76	76	76	72		72	74	70	74

Cardex items carried out: 100H inspection performed; seat belts inspected; 500H inspection performed on LH eng LH magneto, RH engine both magneto's; fire bottle inspected and weighed; LH and RH air filter replaced; NLG downlock pivot bolt replaced; wing tips inspected; LH and RH oil radiator flushed; LH and RH gascolator, bowl and screen: drained, cleaned and inspected; LH and RH eng oil and filter replaced; ELT tested; battery box and cables inspected; emergency exit tested; LH and RH air pressure checked; Lh and RH propeller lubricated; LH and RH propeller sludge removed; pilot and co-pilot seat adjustment system lubricated; door latch mechanism lubricated ---end

AD, SB and CAP's verified or carried out: AD 2004-25-16 R1: fuel regulator and shutt-off valve inspected; SB 1156: NLG drag link inspected and bolt replaced; SAIB CE-11-37 performed on both engines

Notes: Lh eng RH magneto failed 500H inspection: replaced magneto Pn in 4370 Sn in: 11061684; 500H lubrication items performed: rudder and stab trim screw; flap return and tension chains, aileron and stab control chain; RH and LH engine all intake gaskets replaced; LH LDG light bulb replaced; replaced hose from air filter to carburator; TR 10: LDG mute switch light doesn't remain on when cancelled: replaced switch base and test ok; cowl flaps actuating mechanism lubricated; bushing of nose pivot bolt replaced due to corroded; LH nose tire cup and bearing replaced due to worn; LH and RH brake disks replaced due to worn; cable tension aileron, rudder, stabilo and rudder trim out of limits: adjusted cable tension; LH tire and tube replaced; dome light switch nut tightened; Lh oil pressure indication wrong: new transducer installed; turn limit placard missing: placards installed; RH recognition light inop: no stock, deffered to HIL item 14 -end

Checked AD status up to:

FAA :	BW 2011-18	Airframe :	FAA AD 2010-15-10
DGAC :	/	Engine :	FAA 2009-26-12
EASA :	BW 2011-17	Propeller:	FAA 2009-22-03
CAA (B) :	Edition 49	Appliance:	/

Notification for non-compliance
Tasknumber(s) — Owner/operator — Name:
see corresponding MDR(s) — Signature:

The next scheduled maintenance check is due at:
Date: 07-okt-11 Hobbs meter: 1543,3 A/C total time: 1543:18 Hr

I hereby certify that the work as specified above, except as otherwise specified, was carried out in accordance with PART 145 and in respect to that work the aircraft is considered ready for RELEASE TO SERVICE.

Name: Van Damme P. Signature: Van Damme
Authorisation: PART 145 BE.145.28 W.A. A/B1.01 Date: 07-sep-11

5.4 Selected extract of ICAO Annex 6 "International General Aviation – Operation of aircraft" about instruments, equipment and flight documents.

2.4.7 Aeroplanes operated in accordance with the instrument flight rules

Aeroplanes when operated in accordance with the instrument flight rules, or when the aeroplane cannot be maintained in a desired attitude without reference to one or more flight instruments, shall be equipped with:

a) a means of measuring and displaying:

1) magnetic heading (standby compass);

2) the time in hours, minutes and seconds;

3) pressure altitude;

4) indicated airspeed, with a means of preventing malfunctioning due to either condensation or icing;

5) turn and slip;

6) aircraft attitude; and

7) stabilized aircraft heading;

Note.— The requirements of 5), 6) and 7) may be met by combinations of instruments or by integrated flight director systems provided that the safeguards against total failure, inherent in the three separate instruments, are retained.

8) whether the supply of power to the gyroscopic instruments is adequate;

9) the outside air temperature;

10) rate-of-climb and descent; and

b) such additional instruments or equipment as may be prescribed by the appropriate authority.

5.5 Selected extract of ICAO Annex 6 "International General Aviation – Operation of aircraft" about Emergency Locator Transmitter.

2.4.12 Emergency locator transmitter (ELT)

2.4.12.1 **Recommendation.**— *All aeroplanes should carry an automatic ELT.*

2.4.12.2 Except as provided for in 2.4.12.3, from 1 July 2008, all aeroplanes shall be equipped with at least one ELT of any type.

2.4.12.3 All aeroplanes for which the individual certificate of airworthiness is first issued after 1 July 2008 shall be equipped with at least one automatic ELT.

2.4.12.4 ELT equipment carried to satisfy the requirements of 2.4.12.1, 2.4.12.2 and 2.4.12.3 shall operate in accordance with the relevant provisions of Annex 10, Volume III.

Note.— The judicious choice of numbers of ELTs, their type and placement on aircraft, and associated floatable life support systems, will ensure the greatest chance of ELT activation in the event of an accident for aircraft operating over water or land, including areas especially difficult for search and rescue. Placement of transmitter units is a vital factor in ensuring optimal crash and fire protection. The placement of the control and switching devices (activation monitors) of automatic fixed ELTs and their associated operational procedures will also take into consideration the need for rapid detection of inadvertent activation and convenient manual switching by crew members.

5.6 Selected extracts of BCAA KB/AR 9 Jan 2005.

Section VI. - Tous avions volant en IFR.

Art. 41. Tous les avions volant en IFR ou dans des conditions où l'on ne peut conserver l'assiette voulue sans les indications d'un ou de plusieurs instruments de vol, sont munis :

1° d'un compas magnétique;
2° d'un chronomètre qui indique les heures, les minutes et les secondes;
3° d'un altimètre barométrique sensible (les altimètres a tambour et aiguille ne sont plus autorisés à dater du 1er janvier 2004);
4° d'un anémomètre muni d'un dispositif destiné à prévenir les effets de la condensation ou du givrage;
5° d'un indicateur de virage et d'attaque oblique (contrôleur de virage);
6° d'un indicateur d'assiette (horizon artificiel);
7° d'un indicateur de cap (gyroscope directionnel);
8° d'un instrument indiquant si l'alimentation des instruments gyroscopiques est suffisante;
9° d'un instrument indiquant, à l'intérieur du poste de pilotage, la température extérieure;
10° d'un variomètre;
11° de tous autres instruments ou éléments d'équipement prescrits par le directeur général.

Les instruments requis en 5°, 6° et 7° peuvent être remplacés par des combinaisons d'instruments ou par des dispositifs à directeur de vol intégré (flight director), à condition que soient conservées les garanties de protection contre la panne totale, inhérentes à l'existence de trois instruments distincts.

Afdeling VI. - Alle vliegtuigen die in IFR vliegen.

Art. 41. Alle vliegtuigen die in IFR vliegen, of onder voorwaarden waarin men de gewenste positie niet kan bewaren zonder de aanduidingen van één of meerdere vlieginstrumenten, worden voorzien van :

1° een magnetisch kompas;
2° een chronometer die de uren, de minuten en de seconden aangeeft;
3° een gevoelige barometrische hoogtemeter (de hoogtemeters met trommel en naald zijn niet meer toegelaten vanaf 1 januari 2004);
4° een anemometer voorzien van een apparaat dat bestemd is om de gevolgen van condensatie en ijzelvorming te voorkomen;
5° een draai- en hellingaanduider (controle over de bochten);
6° een kunstmatige horizon;
7° een koerstol (gerichte gyroscoop);
8° een toestel dat aanduidt of de voeding van de gyroscopische instrumenten voldoende is;
9° een toestel dat, binnen de stuurcabine, de buitentemperatuur aanduidt;
10° een stijg- en daalaanduider;
11° alle andere instrumenten of onderdelen van een uitrusting die door de Directeur-generaal worden voorgeschreven.

De in 5°, 6° en 7° vereiste instrumenten kunnen vervangen worden door combinaties van instrumenten of door toestellen met geïntegreerde vluchtleider (flight director), op voorwaarde dat de beschermingsgaranties tegen totale panne, inherent aan het bestaan van drie afzonderlijke instrumenten, behouden blijven.

5.7 Selected extract of BCAA requested instruments and equipment for IFR.

4. <u>VOLS AUX INSTRUMENTS DE JOUR ET DE NUIT.</u>

Instruments et systèmes spécifiés aux paragraphes1 et 2.
Un indicateur gyroscopique de cadence de virage.
Un variomètre.
Un horizon artificiel.
Un 2e altimètre sensible, identique à celui du point 1.3.
Une montre avec aiguille centrale des secondes.
Un indicateur gyroscopique de direction.
Un pilote automatique lorsque l'équipage de conduite de l'aéronef est réduit à un pilote.
Un indicateur de température de l'air extérieur, aisément observable par le pilote.
Un système de réchauffage du carburateur pour chaque moteur. (**)
Un indicateur de température du carburateur de chaque moteur. (**)
Un instrument indiquant si l'alimentation des instruments gyroscopiques fonctionne correctement.
Un réchauffage des tubes de pitot pour chaque indicateur de vitesse.
Deux postes émetteurs-récepteurs de radiocommunication VHF. (*)
Un équipement de radio-navigation comprenant les unités suivantes: (*)
- deux récepteurs VOR;
- un récepteur ILS;
- un récepteur MARKER;
- un récepteur ADF;
- un transpondeur mode C avec alticodeur;
- un DME.

Un feu anticollision visible, autant que possible, dans tous les azimuts jusqu'à 30° au-dessus et en dessous du plan horizontal de l'aéronef.
Deux phares d'atterrissage ou un phare d'atterrissage ayant deux filaments alimentés séparément.

4. <u>INSTRUMENTVLUCHTEN BIJ DAG EN NACHT.</u>

Instrumenten en systemen zoals aangegeven in paragraaf 1 en 2.
Een draai- en hellingsaanduider.
Een stijg- en daalaanduider.
Een kunstmatige horizon.
Een tweede gevoelige hoogtemeter zoals bedoeld onder 1.3.
Een uurwerk met centrale naald voor de seconden.
Een gyroscopische richtingsaanwijzer.
Een stuurautomaat wanneer het stuurpersoneel herleid is tot één piloot.
Een buitenluchtthermometer gemakkelijk waarneembaar voor de piloot.
Een systeem van carburatorverwarming per motor. (**)
Een carburatorluchtthermometer per motor. (**)
Een instrument dat de correcte voeding van de gyroscopische instrumenten aanduidt.
Een systeem voor verwarming van de pitotbuizen voor elke snelheidsmeter.
Twee zend- en ontvangtoestellen voor VHF radiocommunicatie. (*)
Een uitrusting voor radionavigatie bestaande uit de volgende eenheden : (*)
- twee ontvangtoestellen VOR;
- een ontvangtoestel ILS;
- een ontvangtoestel MARKER;
- een ontvangtoestel ADF;
- een transponder mode C met alticoder;
- een DME.

Een “anti-collision”-lamp zo goed mogelijk zichtbaar in alle azimuts tot 30° boven en onder het horizontaal vlak van het luchtvaartuig.
Twee landingslichten of één landingslicht met 2 afzonderlijk bekrachtigde filameten.

5.8 Selected extract of Maintenance Manual 'Troubleshooting Landing Gear"

PIPER AIRCRAFT, INC.
PA-44-180, SEMINOLE
MAINTENANCE MANUAL

CHART 1 (Sheet 4 of 4)
TROUBLESHOOTING LANDING GEAR

Trouble	Cause	Remedy
Nose gear fails to steer properly.	Oleo cylinder binding in strut housing.	Lubricate strut housing (refer to Lubrication Chart).
		Cylinder and/or strut housing bushings damaged.
	One brake dragging.	Determine cause and correct.
	Steering arm roller sheared at top of strut.	Replace defective roller.
Nose gear fails to steer properly. (cont.)	Steering bellcrank loose on attachment plate.	Readjust and tighten.
	Steering bellcrank bearing and/or bolt worn.	Replace bearing and/or bolt.
	Shimmy dampener galling or binding.	Replace.

5.9 Selected extract of the Flight School "VFR training Handbook" about Carburettor Icing

BAFA

VFR TRAINING HANDBOOK	3-11
CHAPTER 3	ALL
BASIC FLIGHT MANOEUVRES	01/09/11
BASIC FLIGHT	2.0

AIR EXERCISE 4G The effect of carburettor heat

- Carburettor heater should be used whenever carburettor icing is suspected. Icing can occur between + 20° C and even more, and – 20° C OAT.
- If the aircraft has no carburettor inlet temperature gauge, use the heater always in 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 carburettor 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 carburettor heat control knob fully down ⇒ CARBU ON.
- Using carburettor heater may require a mixture adjustment for smooth engine running (use EGT).

5.10 Selected extract of the "VFR Training Handbook" about the differences between real and simulated engine failure

BAFA	VFR TRAINING HANDBOOK	12-40
	CHAPTER 12	ALL
	NON NORMAL - EMERGENCY SITUATIONS	01/09/11
	POWER-OFF ACCURACY APPROACHES	2.0

DIFFERENCE REAL VERSUS SIMULATED
- The simulation of a forced landing should be similar to the real thing, to the maximum extend possible. However, the engine is still working, so, keep it working. - The trouble check will only be simulated. It is very important to learn every action_by heart as a drill; whenever a real failure occurs, your reaction should be prompt and rather automatic; you will need a lot of energy to plan for a suitable field and to adapt your forced landing pattern. - Forced landings can be simulated over an airfield where a landing or touch and go is possible; you will need prior approval from local ATC. A simulated forced landing in the training area will also be executed; it is good training to make a correct choice of a suitable landing spot, to learn planning in a different environment and helps in confidence
Prior practicing
- Request approval from ATC (at aerodrome) - Remain in the limits of the training airspace - Start at a suitable height - Have a good look out for other aircraft
Throughout the pattern
- Look out for other airplanes: don't get fascinated by your landing field - **Warm the engine regularly: every 500 ft in a descent. In dual the instructor will perform this action**
Engine restart procedure
- Carburettor heat: on depending of real weather conditions - Ignition key: leave it on both, instructor can mention that the propeller has stopped and student must say: I can try a start using the start position
Distress call
- Make no real transmissions, but the student must make a complete mayday call without transmitting it - Do not switch on ELT for simulated procedures, but student must point out the action
Forced landing checklist
- Simulate the actions: let student point out. - Mixture: ~~cut-off~~ ⇒ rich - Fuel selector: ~~off~~ ⇒ on - Ignition switch: ~~off~~ ⇒ on - Alternators: ~~off~~ ⇒ on - Master switch: ~~off~~ ⇒ on - Belts and doors ~~unlatch~~ ⇒ leave closed
Final
- No sideslip with flap setting - Remain above 500ft AGL

5.11 Selected extract of the "MEP Training Handbook" about "Engine Inoperative Landing"

BAFA	IFR TRAINING HANDBOOK CHAPTER 8 ABNORMAL & EMERGENCY OPERATIONS ENGINE INOPERATIVE LANDING	8-15 ALL 01/07/2009 1.0

AIR EXERCISE	VFR Single engine visual circuit

Downwind

- Speed 100 KIAS
- Power: +/- 23" MAP / 2500 RPM
- Perform "Approach checklist"
- Abeam threshold:
- Start timer as applicable for non published circuits.
- Select flaps 10°
- Speed 95 KIAS

Turning baseleg

- Start baseleg as required for published circuit or at end of timing:
  - Required timing: (height / 100) x3 +/- wind correction (1 sec / 2kt wind)
  - Example: downwind at 1000 ft with 10 kts tailwind component
    - ⇨ 25 sec from abeam threshold to end of downwind
- Assure landing clearance before starting descent. Start descend – Power 15"MAP / 2500 RPM
- Carburettor heat on
- Select gear down

Base-leg

- Maintain flap setting!
- Speed 90 KIAS & trim
- Perform "Landing Checklist"

Turning final

- Start final turn not below 500 ft AAL and be established above 300 ft AAL.
- Align aircraft with runway centerline and maintain.

Final

- Maintain speed 90 KIAS
- If landing is assured, select flaps 25°
- Make small power changes of 50 to 100 RPM to correct, to avoid overcorrecting.
- Center rudder trim for landing
- Trim the aircraft!

Short final

- Perform short-final checklist: Carburettor heat off and recheck gear down.

When committed to land

- No go around should be attempted after this point!

BEN AIR FLIGHT ACADEMY JAR-FCL
BAFA ME handbook versie 1.0- Print date: 30/06/2009- Save date: 30/06/2009

5.12 Selected extract of the “MEP Training Handbook” about “Touch & Go’s”

BAFA	IFR TRAINING HANDBOOK CHAPTER 5 NORMAL OPERATIONS APPROACH AND LANDING	5-16 ALL 01/07/2009 1.0

AIR EXERCISE	Touch & go’s

- Fly the correct approach speed in short final:
  - Speed too slow: safety margin with stall speed is reduced
  - Speed too high: aircraft will have a tendency to 'float' during the flare, which will reduce the runway length remaining for the touch and go.
- Touchdown in the first 1/3 of the runway, or go around
- After touchdown, keep right hand on throttles and keep idle power, keep looking outside and maintain runway centerline with the rudder pedals
- Instructor will retract the flaps
- (Instructor will open the cowl flaps, as necessary)
- At the instructors' call, increase throttles to full power.
- At 75 KIAS: rotate.
- Initial climb speed: 90 KIAS
- No more runway available: apply brakes + select gear up.

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