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Report

Accident on Friday **28 October 2011**
at Toulouse Blagnac Airport (31)
to the Piper PA31T
registered **OE-FKG**

BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
Ministère de l'Environnement, de l'Énergie et de la Mer

Safety Investigations

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SPECIAL FOREWORD TO ENGLISH EDITION

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

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Glossary

AMC	Acceptable Means of Compliance
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATO	Approved Training Organization
ATS	Air Traffic Service
BKN	Broken clouds (5 to 7 octas), followed by the height of the cloud base
CAVOK	Visibility, cloud and present weather better than prescribed values or conditions
CPL	Commercial Pilot Licence
CSN	Cycles Since New
EASA	European Aviation Safety Agency
FCL	Flight Crew Licences
FCU	Fuel Control Unit
FEW	Few clouds (1 to 2 octas), followed by the height of the cloud base
FIR	Flight Information Region
FPL	Flight Plan
ft	Feet
FTO	Flight Training Organization
G/S	Glide Slope
HPA	High Performance Aircraft
HSI	Horizontal Situation Indicator
IFPS	Integrated initial Flight plan Processing System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IR	Instrument Rating
ISA	International Standard Atmosphere
JAR	Joint Airworthiness Requirements
kt	Knots
lb	Pound(s)
METAR	Regular meteorological aviation observation message

MHz	Megahertz
NM	Nautical mile
NOSIG	No significant weather changes in 2 hours following observation
P/N	Part Number
QFE	Atmospheric pressure at aerodrome elevation
QFU	Magnetic bearing
QNH	Altimeter setting to obtain aerodrome elevation when on the ground
RPM	Revolutions Per Minute
RQS	Message Request
S/N	Serial Number
SAR	Search And Rescue
SEP	Single Engine Piston
SCT	Scattered clouds (3 to 4 octas) followed by the height of the cloud base
SESAR	Single European Sky ATM Research
RFFS	Rescue and Firefighting Service
TAF	Terminal and Alternate Forecast
TRTO	Type Rating Training Organization
TSN	Time Since New
UTC	Coordinated universal time
VFE	Maximum speed Flaps Extended
VHF	Very High Frequency (30 to 300 MHz)
VLO	Maximum speed gear Extended
VMC	Visual Meteorological Conditions
VMCA	Minimum airspeed at which an airplane is controllable with an inoperative critical engine and its propeller not feathered, in clean configuration
VNE	Velocity Never Exceed
VOR	VHF Omnidirectional Radio Range
Vs	Stall speed

Synopsis

Asymmetric thrust, loss of control on final approach, collision with ground, fire

Aircraft	Piper Aircraft PA31 T registered OE-FKG
Date and time	Friday 28 October 2011 at 19 h 35[1]
Opertor	Private
Place	Toulouse Blagnac (31) Airport
Type of flight	General aviation
Persons on board	One pilot and three passengers
Consequences and damage	Pilot and three passengers fatally injured, aeroplane destroyed

[1]All times in this report are UTC, except where otherwise specified. Two hours should be added to obtain the legal time in metropolitan France on the day of the event.

ORGANISATION OF THE INVESTIGATION

Two BEA investigators were sent to the accident site.

Austria, State of Registry and State of Operator, the United States, State of Design and Manufacture, Canada, State of Engine Design and Manufacture and Germany, State where the last maintenance check was carried out, were notified. Each named an accredited representative to participate in the Safety Investigation.

The European Commission and EASA were also notified in accordance with European Regulation 996/2010.

SUMMARY

The pilot, accompanied by three passengers who were family members, took off at 16 h 35 from Kassel (Germany) aerodrome for a private flight under IFR to Toulouse-Blagnac. After about three hours of flight, he was cleared for approach and received radar vectoring for the runway 14R ILS. During the last exchange with the controller, as the aeroplane was on final at 900 feet, the pilot stated that he had a problem without specifying what type, as the message was interrupted. Shortly afterwards, radar and radio contact was lost. The wreckage was found close to the threshold of runway 14R.

The pilot and the three passengers were fatally injured.

CAUSES, CIRCUMSTANCES AND THEMES OF RECOMMENDATIONS

An anomaly on the right engine led to thrust asymmetry. The pilot did not react early enough to the drop in speed and encountered some difficulties in handling the thrust asymmetry before losing control of the aeroplane.

Continuing a fast arrival without external visual references, get-home-itis and inadequate and inappropriate type rating training may have contributed to the occurrence of this accident.

Theoretical and practical training of aircraft flight crew and oversight of training organisations are the subjects of five Safety Recommendations.

1 - FACTUAL INFORMATION

1.1 History of Flight

The pilot, accompanied by three passengers who were family members, took off at 16 h 35 from Kassel (Germany) aerodrome for a private flight under IFR to Toulouse-Blagnac. After about three hours of flight, he was cleared for approach and received radar vectoring for the runway 14R ILS. During the last exchange with the controller, as the aeroplane was on final at 900 feet, the pilot stated that he had a problem without specifying what type, as the message was interrupted. Shortly afterwards, radar and radio contact was lost. The wreckage was found close to the threshold of runway 14R.

1.2 Injuries to Persons

The pilot and the three passengers were fatally injured.

1.3 Damage to Aircraft

The aeroplane was destroyed.

1.4 Other Damage

Not applicable.

1.5 Pilot Information

Male, aged 49.

Holder of an Austrian CPL licence issued on 9 January 1995, validated as JAR FCL N° CPL A-2113-JAR licence

- SEP valid until 18 June 2012.
- PA31/42 type rating with an IR rating, obtained on 30 November 1995, extended in 1996 and renewed on 18 June 2011, valid until 18 June 2012.
- C500/550/560 IR copilot rating, valid until 18 June 2012
- Class 1 medical certificate valid until 19 April 2012.
- German language level 6 and English level 4, both valid.

Experience:

- total: 1,145 flying hours, including 834 as captain and 828 in IFR;
- on type: 124 from 1995 to 1997 and 93 in 2011, making 217 flying hours;
- in the last three months: 50 hours, 24 take-offs and 23 landings on type;
- in the last seven days: 3 hours on type.

The pilot had obtained his PA31T type rating in 1995 and had flown regularly until 1997. He had not flown on this aeroplane again until June 2011, when he had renewed his PA31T type rating in an approved Austrian school. Renewal of the PA31T type rating (identical programme to that of the initial type rating) was carried out during fifteen flying hours spread out over four days. All were recorded in IFR in the pilot's logbook. The instructor who oversaw the training stated that around 2 hours were performed in VFR in order to undertake asymmetric flight exercises.

The pilot regularly undertook return flights from Austria or Germany to Toulouse, where he lived.

1.6 Aircraft Information

1.6.1 Background

Commercially the PA31T is called the Piper Cheyenne II. It is a light twin-engine, high performance aircraft, pressurised and equipped with two PT6-A28 turboprops. Its maximum weight on take-off is 4,082 kg.

OE-FKG had six seats. Its total fuel capacity of 1,385 litres gave it a range of about 4 h 30 of flight (ISA conditions, 2,000 RPM in cruise, FL240).

Figure 1 - OE-FKG

Airframe

Manufacturer	Piper Aircraft Corporation USA
Type	PA-31T
Serial number	31T-8020036
Registration	OE-FKG
Entry into service	22 August 1986
Certificate of Airworthiness	OE-FKG/16-6/08 on 9 February 2009 valid until 6 February 2012
Use by 01/10/2011	7,300 flying hours and 5,434 cycles

1.6.2 Speeds

Limit speeds that are useful in understanding the accident

Maximum speed	kt(IAS)
Flaps at 15° VFE	181
Flaps at 40° VFE	148
Landing gear extended VLO	153
VMCA Minimum airspeed at which an airplane is controllable with the critical engine inoperative, with its propeller unfeathered, in clean configuration[(2)]	91
Stall speed in conditions on the day, flaps 40°	75

[(2)]Conditions described in the aeroplane flight manual.

On a twin-engine aircraft when one engine has failed, the yawing moment generated by asymmetrical thrust must be countered by pilot inputs on the controls, mainly the rudder pedals.

When the aircraft speed decreases, the aerodynamic effect on the vertical stabiliser and the rudder decreases and the deflection of the rudder pedal should increase. There is a speed (VMCA) below which the pilot can no longer prevent yaw movement, the rudder being fully locked. Its value has been demonstrated during test flights in the most adverse weight and balance conditions, when the critical engine is inoperative and the other engine is producing maximum power.

1.6.3 Weight and balance

At the time of the accident, the aeroplane weight and balance were within the limits defined by the manufacturer.

1.6.4 Engines

	Left Engine	Right Engine
Manufacturer	Pratt and Whitney Canada	Pratt and Whitney Canada
Type	PT6A-28	PT6A-28
Serial number	PCE52163	PCE 52178
Total operating time since installation	7,300[3]	7,300[3]
Operating time since general overhaul	188[3]	209[3]
Propeller type	HC-B3TN-3B	HC-B3TN-3B
Propeller series number	BUA-19571	BUA-19569
Propeller operating time since last overhaul	392[3]	392[3]

[3]As of 27/10/2011.

The aeroplane was not equipped with an automatic feathering system.

1.6.5 Emergency procedures in the event of engine failure

The Flight Manual includes the following procedures:

- ENGINE FAILURE DURING FLIGHT (Above 91 kt)
  This procedure requires a speed of 113 kt and directional control to be maintained.
- SINGLE-ENGINE APPROACH AND LANDING
  This procedure requires, in particular, the feathering procedure of the failed engine to be accomplished, the flaps to be set in approach configuration (15°), a speed of 113 kt to be displayed, the landing gear to be extended and then the flaps to be in “*full down*” position “*when the landing is ensured*”.

A manufacturer’s note draws crews’ attention to the fact that a go-around cannot be undertaken if the aircraft speed is less than 113 kt or if the flaps are extended to 40°.

1.6.6 Maintenance

The last scheduled maintenance check was an "*Event 1*" type, carried out from 19/10/2011 to 28/10/2011 at TSN 7 300 and CSN 5 434.

In the context of this check, inspection and lubrication operations were carried out on the propellers. Concerning the engines, verifications were carried out on the following systems:

- inspection of the ignition circuit;
- air and fuel filter cleaning;
- inspection of the fuel circuit;
- de-icing system;
- oil level;
- inspection of the P3 air filter (supplying air to the FCU);
- check on engine performance (no anomaly was brought to light during this check).

The KDC 380 Air Data Computer and the KCP 320 Flight Computer were updated.

1.7 Meteorological Information

1.7.1 General situation

The situation was characterised by a south-east wind, humid but slightly disturbed. The wind was low.

The estimated conditions on the site were the following:

- wind 100 to 120°, 2 kt maximum 4 kt;
- 2/8 of stratus at 600 ft, 4/8 of stratocumulus at 1,300ft and 7/8 of stratocumulus at 2,000 ft;
- no significant phenomenon;
- visibility: 9 000 m;
- temperature: 14 °C;
- dew point: 13 °C;
- Iso 0° C altitude: 3,000 m;
- QNH: 1023hPa.

1.7.2 Meteorological observation at 20 h 30

The LFBO METAR was as follows:

- LFBO 282030Z 08003KT 9000 FEW006 SCT016 BKN026 14/13 Q1023 NOSIG=

1.7.3 ATIS recording

- U information recorded at 18 h 25 min;
- runways in service 14;
- ILS approach runway 14R;
- runway 14L used on take-off;
- Departure route 5A;
- transition level 50;
- calm wind;
- visibility 10 km;
- scattered clouds at 600 ft, broken at 2,300 ft;
- temperature +14°C Dew point +13°C;
- QNH 1023 QFE 1005.

1.8 Aids to Navigation

The pilot received radar vectoring for an ILS approach to runway 14R.

The ILS maintenance recordings did not show any malfunction.

1.9 Telecommunications

Radio communications between the pilot and the Toulouse approach controller were recorded. Only the following extracts were relevant in the context of the investigation.

Between 19 h 27min 39 s and 19 h 27min 59 s, because of the imminent arrival of an airliner, the controller and the pilot communicated about the approach speed of OE-FKG:

> *Controller: - Oscar Kilo Golf say your speed?*
> *Pilot: - Err … two….Two three zero (*) Kilo Golf*
> *Controller: - Oscar Kilo Golf for time being maintain two three zero knots if you can*
> *Pilot: - I will try (as long as I can) Oscar Kilo Golf*

At 19 h 32 min 41 s, the pilot announced:

> *Pilot: -Oscar Kilo Golf […], just a moment I have a problem with one*

This message was the last exchange with the controller.

1.10 Aerodrome Information

Toulouse Blagnac airport has two parallel paved runways oriented 14/32 and offset by 1,150 m from threshold 14. Runway 14R/32L is 3,500 m long and is located south of runway 14L/32R, which is 3,000 m long. The two runways are 45 m wide. The airport reference altitude is 499 ft.

Runway 14R, used for landing during the accident, is equipped with an ILS and a precision approach lighting system. This system includes approach lights formed of sequenced flashing lights, 870 m long, located entirely within the aerodrome area, of high intensity lighting of the runway threshold and the touchdown zone as well as coded centre line lighting.

The emergency services were located about 2,000 m from the threshold of runway 14R.

1.11 Flight Recorders

The aeroplane was not equipped with flight recorders. The regulations do not require this.

1.12 Wreckage and Impact Information

1.12.1 Site examination

The main wreckage was grouped together and partly burned. It was located about 40 metres to the right of the centre line approach lights and 640 m from the beginning of runway 14R. It came to a stop on its back on a magnetic bearing of 270°.

Figure 1 - accident site

1.12.2 Wreckage examination

The aeroplane was in landing configuration. The propeller and left external tank lay about 15 m before the main wreckage indicating, like the distortion to the left wing, that the latter hit the ground first. The flaps were extended symmetrically to 40°.The absence of marks on the landing gear indicated that the aeroplane struck the ground on its back during this first impact. Its pitch attitude was approximately 20° to the ground. Skid marks from the front of the cabin were visible over twenty metres on a line oriented 165°.

A fire subsequent to the impact started on the left wing (leading edge and upper wing surface) as well as on the forward part of the cabin. The instrument panel was seriously damaged by the fire.

The flight control linkages were unbroken.

The right rudder pedal was depressed to the right. The rudder was locked to the right on impact and the yaw load compensator was positioned to the left.

The "*EMERGENCY PROCEDURES*" check-list was found near the passenger seat, open at the "*ENGINE INOPERATIVE PROCEDURE*" page.

1.13 Medical and Pathological Information

Analyses carried out on the aeroplane occupants did not bring to light any element likely to explain the accident.

1.14 Fire

A witness on the ground indicted that he did not observe any smoke or flames during the aeroplane's final approach. The fire resulted from the accident.

1.15 Survival Aspects

1.15.1 Survival

The occupants of the front seats were fatally injured on impact.

The airport fire brigade came to the assistance of the passengers in the rear seats. They were unconscious and lying on the ground (the cabin ceiling). Their safety belts were not attached. Both succumbed, a few hours after the accident, to poisoning caused by inhaling the fumes from the fire.

1.15.2 Number of persons on board

When a pilot files a flight plan, he can fill in the information relating to the number of persons on board in box 19. This information is then available via the air traffic services, which accepted the flight plan, or, in the case of FPL IFR, from the IFPS (Integrated initial Flight plan Processing System). However en route and destination services do not have the information that is in box 19 and in particular the number of persons on board. This information may be the subject of a specific message request (RQS) to the Regional office for flight information and assistance (BRIA) linked to the departure aerodrome or directly to the IFPS. An automatic response is then obtained by a supplementary information message (SPL) with the contents of box 19.

In the case of this event, during the rescue operation, specific clues might have led to the belief that a fifth person was on board. All resources were deployed in order to find this person and a request for help was addressed to the Blagnac control authority in order to acquire the information declared in the submitted flight plan.

Confirmation of the declaration, in box 19 of the FPL, of the presence of four occupants came about two hours after the accident and brought the search to an end.

This query procedure (RQS) was not implemented on the day of the accident and those in charge of the search accessed this information by telephone, with some delay.

In France, any pilot of an aircraft who contacts a military air traffic authority is questioned, during the first radio contact, as to the number of persons on board. This practice enables search and rescue time to be optimised, independently of the flight regime (IFR or VFR) or of the filing of a flight plan.

This practice is not required by the Air Traffic Regulation and is not systematic during radio exchanges between pilots and civil air navigation control authorities.

1.16 Tests and Research

The Toulouse secondary radar data were used in order to reconstitute the last five minutes of the aeroplane's flight path. Changes of altitude and ground speed were analysed.

1.16.1 Analysis of the flight path

The pilot was in contact with Toulouse-Blagnac approach. The aeroplane was at 3,000 ft, after descending gradually from FL80, with an announced speed of 230 kt.

At 19 h 27 min 53 s, the controller requested the pilot to maintain this speed as long as possible. The pilot replied in the affirmative.

At 19 h 28 min 16 s, the pilot was cleared for ILS approach to runway 14R. He received radar vectoring.

At 19 h 29 min 47 s, the pilot contacted the tower.

At 19 h 30 min 19 s (point❶), the aeroplane captured the ILS (LOC) axis with a slight overshoot. The average ground speed was around 230 kt.

At 19 h 30 min 44 s (point❷), the aeroplane intercepted the glide slope (G/S) and followed it. The average ground speed was around 185 kt.

At 19 h 32 min 02 s, the pilot was cleared to land. The reported wind was calm.

Between 19 h 32 min 23 s (point❸) and 19 h 33 min 02 s, the aeroplane descended to 1,470 ft altitude then climbed slightly. Its average ground speed decreased from 185 kt to about 80 kt in forty seconds. During this period, the aeroplane flew above the glide slope.

At 19 h 32 min 41 s (point❹), the pilot announced "*… just a moment I have a problem with one …(*)…(*)…* ". The aeroplane's descent gradient increased, it then went below the glide path.

The last radar contact was dated at 19 h 33 min 57 s at point❺. A final inaudible message was transmitted by the pilot.

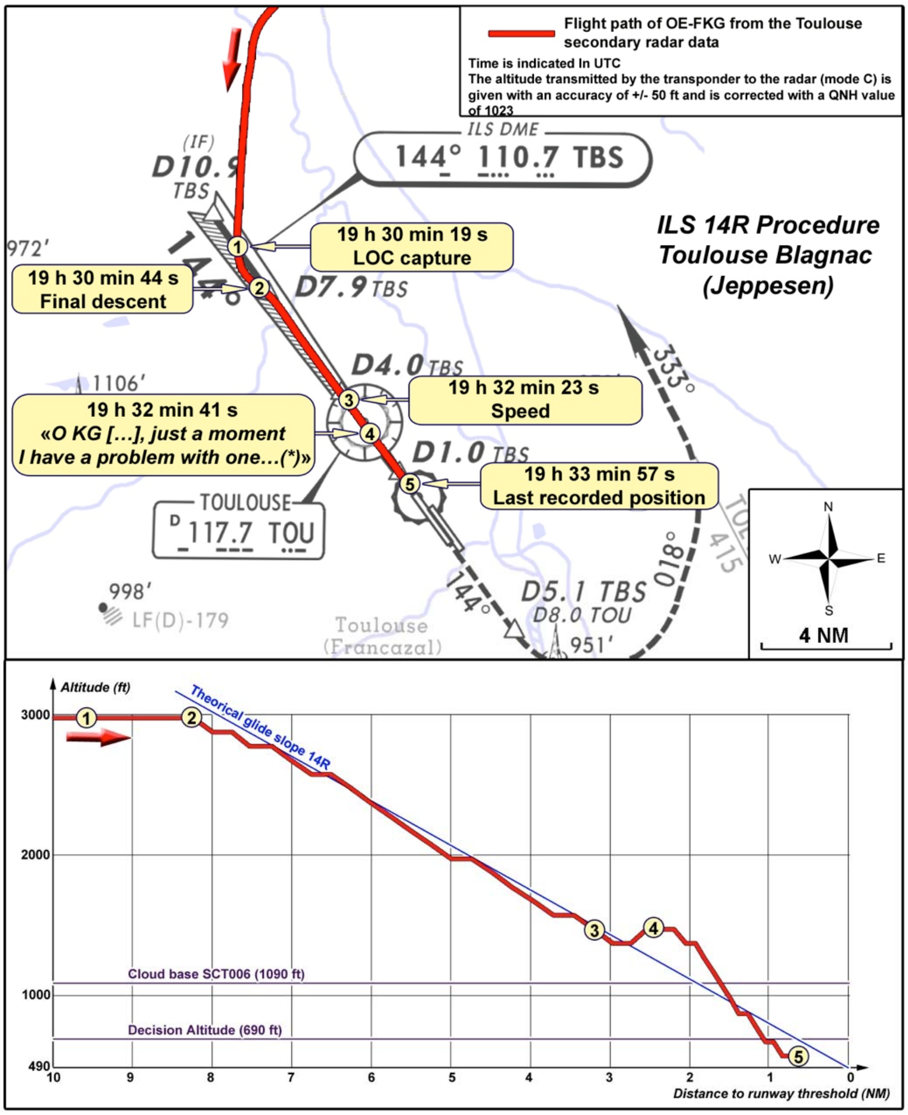

Figure 3- OE-FKG approach trajectory

Although there is no regulation on this, the stabilisation criteria for an IFR approach are generally set at 500 ft in visual flight conditions and 1,000 ft in IMC.

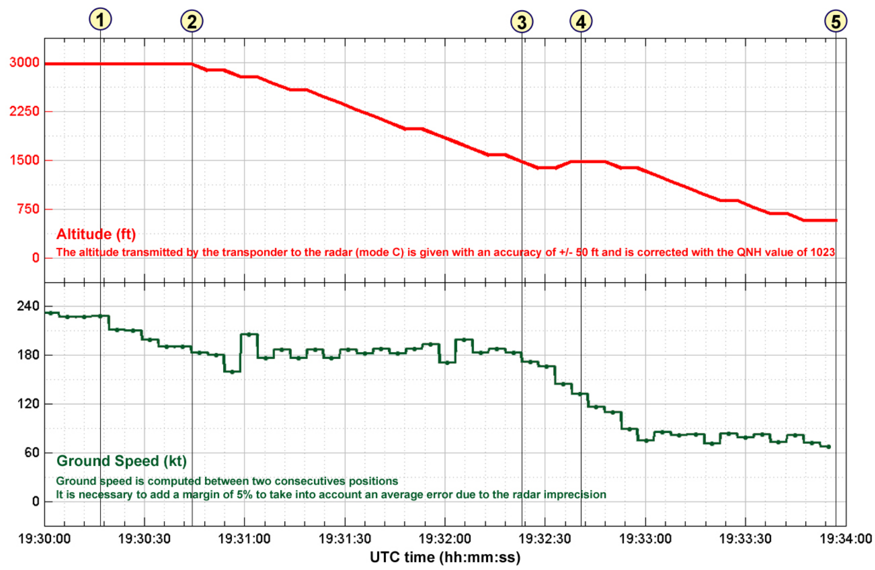

Figure 4 - OE-FKG approach flight path - Vertical profile and ground speed

1.16.2 Radar data analysis

The precision of the altitude information did not allow a refined analysis to be made of the LOC capture, then the aeroplane's descent. However, the variations in altitude and overshooting the approach axis are consistent with an interception on autopilot, given the high speed.

1.16.3 Spectral analysis of the ATC tapes

Six messages were noted from OE-FKG on the approach frequency between 19 h 16 min 00 s and 19 h 29 min 35 s, followed by four messages on the tower frequency between 19 h 29 min 40 s and 19 h 34 min 00 s. Of this total of ten messages received, six showed clearly marked spectral information relating to power units (propeller spectrum). Analysis of this data enabled a propeller rotation speed of between 1,850 and 1,860[4] rpm to be deduced.

The relatively small volume of recordings of ambient noise without voices did not make it possible to bring to light a mechanical malfunction associated with one or other of the engines.

1.16.4 Engine examination

The examinations were carried out in three phases:

- Examination of engines at the French defence agency, Engine tests (DGA EP) then removing specific equipment from engines 1 and 2 for examination and bench testing at PWC.
  Examination of propellers at DGA EP.
- Examination and bench testing of following equipment by PWC:
  - Fuel control unit
  - Fuel pump
  - Start Flow control unit
  - Propeller governor
  - Overspeed governor
- Examination of specific electrical cables from the right engine carried out by the DGA EP. This examination aimed to determine the presence of possible[5] damage which may have led to an activation of the feathering vanes or to a regulation to slow flight.

Phase 1 : Work carried out on the engines by the DGA EP

Examinations of the two engines established the following facts:

- the left turboprop was functioning and delivering greater power than the right turboprop at the time of impact with the ground;
- a mix of oil for turbine engine and fuel was identified in the P3 air regulating line[6] from the FCU;
- the damage noted was the result of the accident or the fire that occurred after impact.

[4] The normal range is between 1,800 and 2,000 rpm.

[5] A person in charge of the service unit who undertook the maintenance of a PA31T informed us of certain problems which led to regulating to engine idling.

[6] This line is usually dry.

Phase 2: Work carried out by PWC

Examination of various equipment listed in point 2 below made it possible to establish that they were operating in accordance with specifications.

The fuel extracted was in compliance with specifications for use.

Phase 3: Additional inspection of specific electric circuits in the right engine by DGA EP

The examinations consisted of inspecting the electrical wires of two harnesses leading from the rear of the turboprop unit to the front. The damaged electrical wires (damaged sheath, heating marks, etc.) did not concern the feathering vanes electrical circuit.

However, it was noted that the heating marks on some wires that were located inside the orange taping had no visible external marks of heating. This damage did not result from the post-impact fire.

Partial conclusion

The left engine was functioning and delivering power greater than that of the right engine at the time of impact with the ground.

Examinations of the regulating systems and equipment did not make it possible to explain the reason for this difference in power.

The presence of fluid was noted in the air regulating line without it being possible to identify its origin.

The two propellers were close to fine pitch in their regulating range, indicating that feathering had not been commanded on the right engine.

1.17 Information on Organisations and Management

The Flight Training Organisation (FTO) that provided instruction to renew the PA31T type rating filed a training programme with its authority in compliance with the one provided for by the FCL regulation. It included four days of theory and six sessions of in-flight instruction for a minimum total of ten hours. The renewal programme is identical to that of the first type rating.

The pilot's training file was archived and included details of the instruction details. This file was compared to the pilot's log book.

Session 4 covered single engine flight and particularly the single engine missed precision approach, single engine precision approach and visual approach, and single engine landing.

Session 5 included revision of the items covered during sessions 3 and 4, such as single engine landing.

During this training course, the pilot recorded about twenty flying hours with an instructor, including about fourteen on legs of two hours or more. All the flights were logged as being in IFR in his[7] log book.

[7]The instructor stated that he recorded 2 h 30 in VFR in his own logbook.

Sessions 4 and 5 were carried out on 20 June 2011, during two Toulouse-Kassel return trips, of a respective duration of 3 h 09 and 3 h 34. The radar trajectographies of the Toulouse Blagnac arrival and departure were analysed. Taking into account the available time, the exercises planned in these sessions could not have been carried out.

1.18 Additional Information

1.18.1 Training for type rating – JAR FCL

The PA31T is classified as a single pilot multi-engine high performance aeroplane, for which the JAR FCL regulation provides a type rating. This training must be delivered by an FTO or TRTO. The training content is defined by the JAR-FCL 1.261 completed by the AMC 1.261 c) 2. The list of exercises that must be undertaken in the framework of issuing this type rating is defined in Appendix 3 of JAR-FCL 1.240. The engine failure exercise is covered specifically during take-off. Simulated asymmetric flight is an exercise which can be combined with others.

The candidate for this type of rating must meet additional conditions defined by the JARFCL 1.251 (and Appendix 1 of the JARFCL 1.251).

Appendix 1 of JAR-FCL 1.261(a), completed by the AMC FCL 1.261(a), includes the subjects which should be covered by the theoretical training to issue the type rating. The AMC FCL 1.261 (a) plans to cover VMCA in chapters 2.1.2 Limitations and 3.1 Performance.

1.18.2 Regulatory training for type rating – PART FCL "AIRCREW"

In the new European regulation Part FCL[8], the PA31T is considered as a single pilot complex high performance aeroplane. The regulation specifies that it should be treated as a multi-pilot aeroplane, whereas this regulation is adapted to performance of exercises on a simulator. Most of the time, this category of aeroplane has flight simulators available. Multi-pilot aircraft have, for the most part, flight simulators that make it possible to perform these exercises. On the contrary, simulators for complex single pilot high performance aircraft, such as the PA31T, are rare or non-existent.

[8] Applicable in France since 4 April 2013.

The AMC 2.ORA.ATO.125 specifies that in-flight training performed exclusively on an aeroplane, without using a simulator, does not cover all abnormal and emergency operations required for the training and the aptitude test for type rating. In such cases, the ATO must demonstrate to the competent authority that adequate training on these aspects is delivered by other means.

Further, training on the aeroplane implies set-up time to determine an acceptable flight situation. This may include ATC constraints, delays due to ground traffic before takeoff, the need to reach safety altitudes to perform the exercises or appropriate training areas. It can include physically repositioning the aircraft or repeating manoeuvres or instrument approaches. In this case, the competent authority ensures that the training programme is adapted to these hazards and that it contains the minimum quota of hours required for the training. Finally, the risks associated with the execution of some failure exercises in real flight, in particular those that involve asymmetric traction, can lead to limiting the phases of flight in which they can be executed, or even reducing the number of exercises performed.

In 2010, a BE90 crashed in the south of France while the pilot was undertaking a failure exercise.

In addition, the training programme for asymmetric flight on takeoff or on approach is not detailed for a complex high performance single pilot, such as the PA31T, though it is for non-complex single pilot aircraft.

1.18.3 Testimony

A witness indicated that he had observed the aeroplane's approach and saw it turn suddenly to the right and descend. He stated that he did not see any flames during the final approach and that he did not see the impact with the ground.

Examination of a video

Examination of a video recording by a camera filming the airport installations made it possible to see the aeroplane's landing lights while on approach. This video was made facing the final approach. It showed a sudden deviation of OE-FKG's landing light halo to the left of the screen, that is to say an aeroplane flight path to the right, associated with a rapid fall to the ground. The estimated height of the aeroplane just before its fall was 150 ft considering that it was following the glide path. This height was lost in approximately one second.

1.19 Useful or Effective Investigation Techniques

A flight test in a PA31T was performed on 24 August 2012 to validate the radar data read out that were used to produce the vertical descent profile . BEA investigators established a flight programme to determine, in comparison, the configuration of the aeroplane according to observed performance. Three approaches were carried out during which the approach configurations and speeds were modified.

The following objectives were set:

- to simulate a fast arrival (190 kt) on the ILS axis on autopilot and to check if an overrun was possible to determine whether the approach on the accident flight had begun on autopilot or not;
- To establish the engine pre-selections during a descent at constant speed (180 kt) on a 5% slope;
- To note the effects of the change of configuration (extending flaps 15° and extending landing gear) during a descent on autopilot to compare them to OE-FKG's radar vertical profile;
- To note the effects of the change of configuration (extending flaps 15° and extending landing gear) during a manual descent;
- To establish a power management profile to obtain a deceleration from 175 kt to 90 kt (over a time between 25 and 30 seconds) on a 5%.glide slope

The aeroplane was equipped with two portable GNSS receivers and a light video recorder. The data recorded by the three computers and the flight radar data were used.

1.19.1 First approach

The first approach consisted of a decelerated ILS approach (starting from 190 kt) conducted according to the standards taught by the instructor pilot:

- interception of the ILS axis;
- gradual reduction of power;
- extending flaps 15°;
- interception and following glide slope;
- extending landing gear;
- extending flaps 40°;
- adjusting power to maintain speed.

Extension of drag inducing elements took place within the flight manual VFE .

The first approach showed that interception of the ILS axis, with the autopilot engaged[9] with a speed of 190 kt, did not lead to overshooting the axis.

[9]The autopilot on the accident flight was different from the one on the aeroplane used for the flight tests.

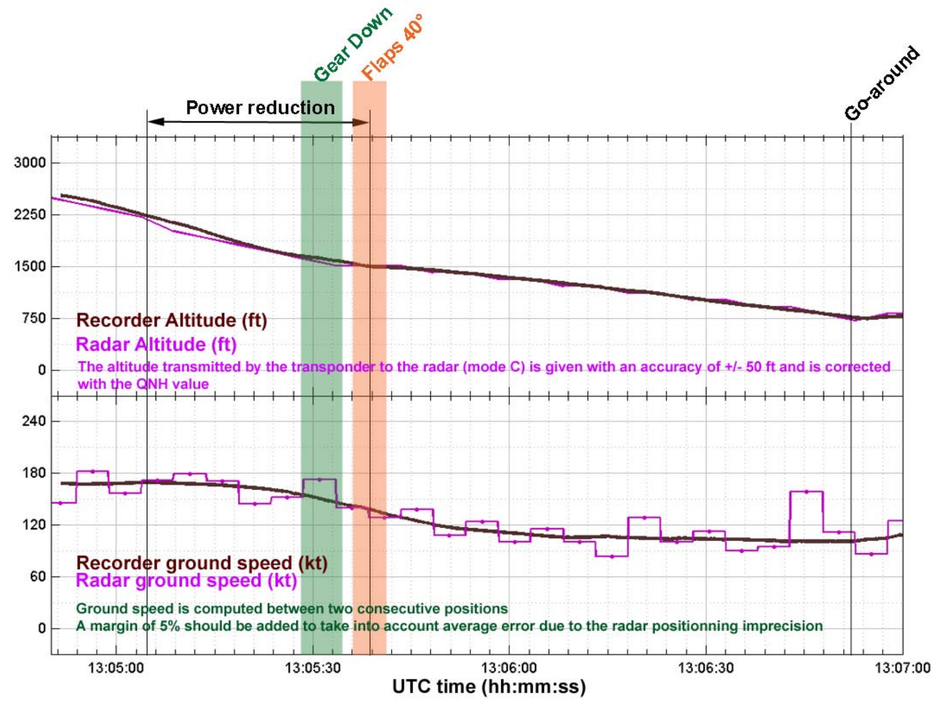

Figure 5 - First approach

1.19.2 Second approach

The second approach aimed to reproduce the decelerated ILS approach on the accident flight starting from interception of the ILS axis at about 190 kt and targeting a final speed of around 90 kt.

Deceleration was delayed in such a way as to intercept and follow the glide path at a speed of 185 kt. The engine power was adjusted. The decrease began 1,000 ft above ground level and the extension of drag devices was in compliance with the flight manual VFE.

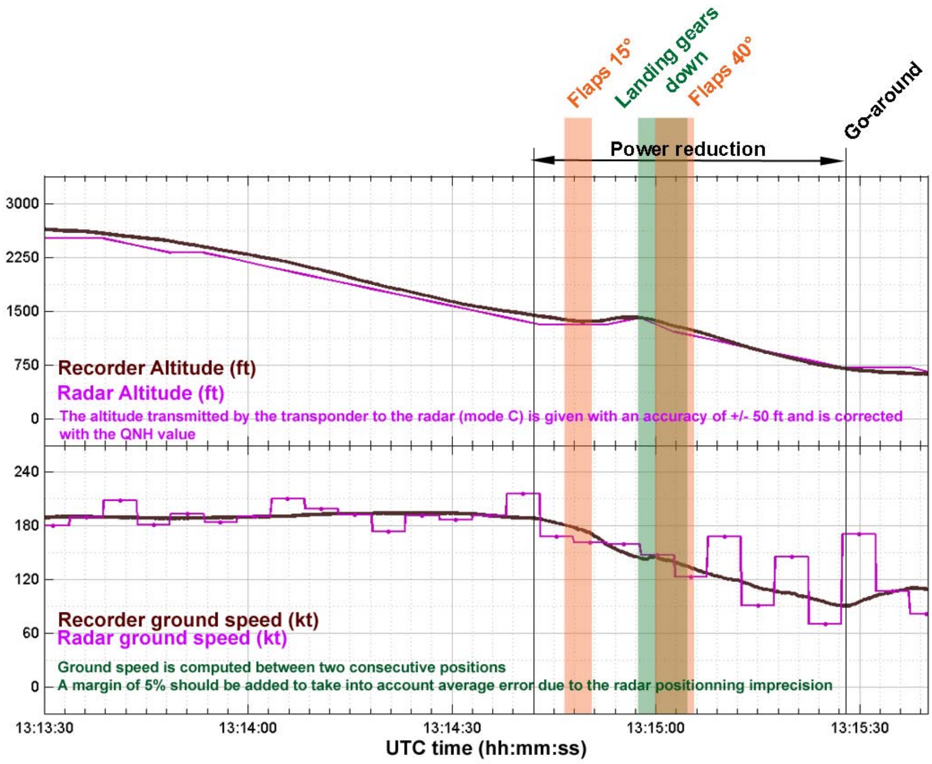

Figure 6 - Second approach

1.19.3 Third approach

The third approach was conducted in an identical manner to the second though flying manually. A nose-down input on the trim was required to reduce control inputs effort. The deceleration phase and extension of drag devices was timed in order to compare it to the accident flight.

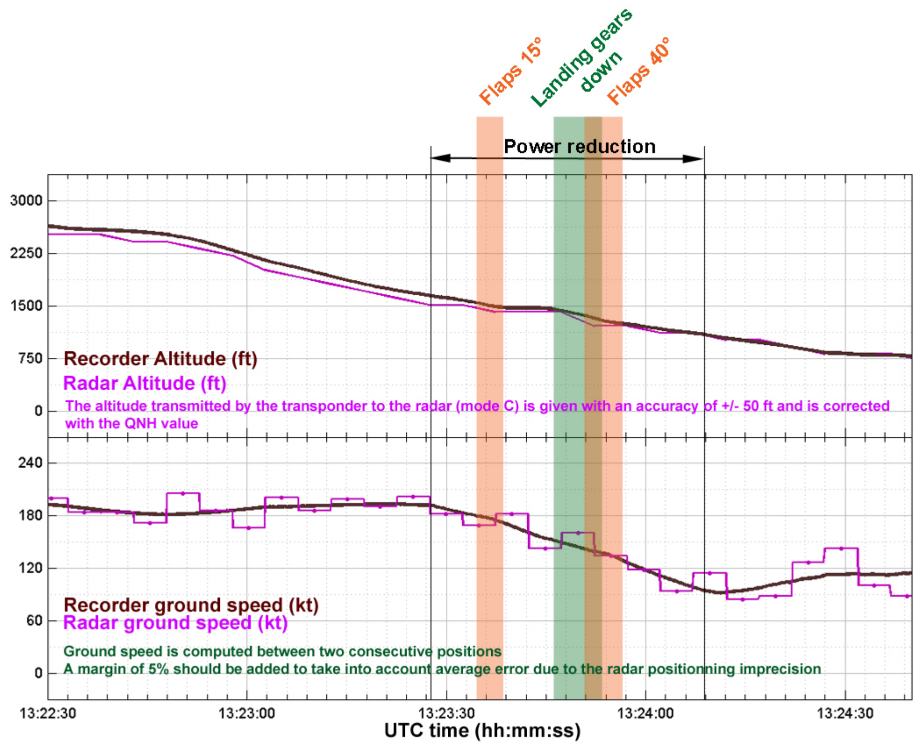

Figure 7 - Third approach

1.19.4 Analysis of results

The flight test took place in performance conditions close to those of the accident. It showed that:

- analysis of the radar recordings enabled a reliable analysis of the ground speed;
- on autopilot, interception of LOC at a speed of 190 kt did not generate a deviation detectable on the horizontal situation indicator (HSI) or in the radar data;
- continuation of the descent at 180 kt required a torque of 600 lbs (40%) in a twin-engine. It would be impossible not to notice traction asymmetry if the engine failure occurred during this phase;
- during a fast arrival (>165 kt), 15° flap extension generated a pitch-up moment that neither the autopilot nor manual piloting via the compensator could compensate sufficiently quickly to avoid passing above the glide slope;
- the aeroplane continued to decelerate on extension of flaps to 40°;
- the sequence of speed reduction from 180 kt to 90 kt and extension of drag devices at the flight manual VFE lasted 45 seconds. To reduce this, it is necessary to exceed the maximum speeds of extension of drag devices.

2 - ANALYSIS

2.1 Engine Power during Approach

The attitude of the aeroplane on impact, the decrease in ground speed and the video recording showed that the accident resulted from loss of control of flight symmetry.

Although the examinations did not bring to light any malfunction of the engines or of their regulation systems, they revealed that the right engine was delivering less power than the left at the time of impact. This traction asymmetry may explain the asymmetrical character of the loss of control.

The pilot's last message indicated that he was encountering a problem. The difference in power observed between the engines at the time of impact may have been either the result of the failure of the right engine or that of the voluntary reduction by the pilot in response to an anomaly noticed on the instruments.

The presence on board of the check-list open at the page dealing with engine failure seems to confirm that the pilot was confronted with an engine anomaly.

The *"Event 1"* maintenance check carried out before the flight was limited to simple operations on the engines. Verification of their performance did not show any anomaly. Examination of the engines did not make it possible to understand the nature or the origin of the anomaly.

However, failure of an engine in flight is provided for in the procedures. The following analysis therefore focused on trying to understand why the pilot was not able to apply them.

2.2 Description of the Approach

Arrival strategy

The approach controller asked the pilot if it was possible for him to maintain his speed. The pilot confirmed to him that he would maintain it as long as he could. He was probably influenced by this request not wanting to interfere with the airliner which was number two on approach and he decided to carry out a fast approach. This exchange took place about five minutes before interception of the localizer. His speed was about 230 kt on interception of the localizer and dropped as far as 185 kt on interception of the glide path. Decrease to the speed enabling extension of the landing gear began shortly before 1,000 ft from the ground. The pilot was at that moment in IMC conditions and, given the meteorological conditions, had probably acquired visual ground references.

This approach did not meet stabilisation criteria: extended centre line, glide slope, configuration, speed, vertical speed.

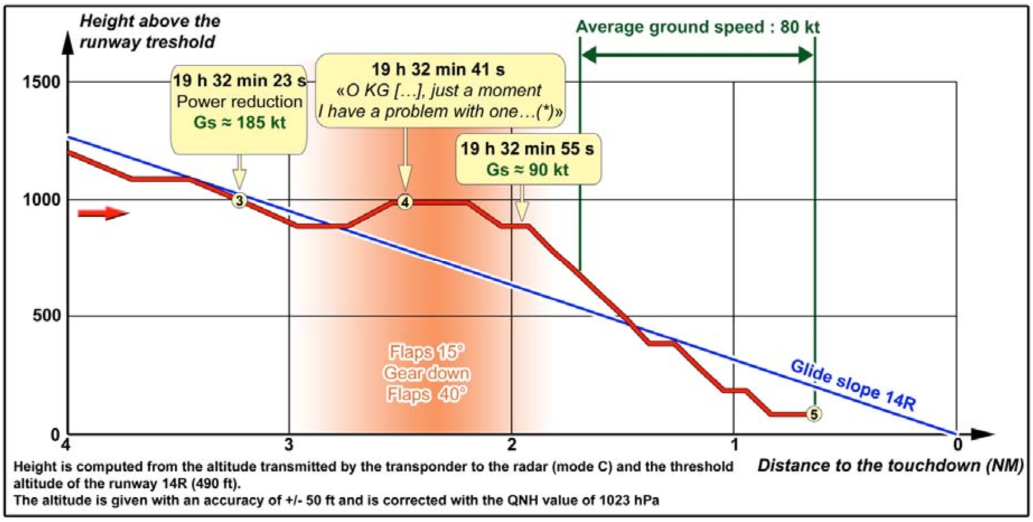

Figure 8 - Probable sequence of flap and gear extension during final approach

Detection of an anomaly

The approach was conducted at high speed down 1,000 ft/ground. The pilot then probably reduced power in order to change to approach configuration and landing, in sequence. Extending flaps to 15° gave the aeroplane a pitch up moment, which if it is not immediately countered, leads the aeroplane to deviate upwards above the ILS glide slope.

It was at this moment that he detected and called out abnormal behaviour. He then told the controller "*one moment, I have a problem with one …*" and did not finish his phrase. Examination of the wreckage did not reveal any flap asymmetry, or roll control failure. Consequently, this behaviour was probably related to a malfunction of the right engine. The pilot was confronted with a considerable increase in his work load and simultaneously had to carry out actions relating to handling this anomaly, return to the ILS glide slope and monitor his speed reduction.

Asymmetry, if it had not occurred before the power was decreased, would have been detectable given the power required to maintain speed. From this moment, and until there is a significant increase in power, detecting it is more difficult.

The detection and then the processing of the anomaly did not lead the pilot to consider missing the approach or enable him to stabilise it.

It is impossible to say if the change in flaps to the landing position occurred before or after detection of the anomaly, or to know the aeroplane's speed at this time (between 125 and 90 kt). The flight manual specifies that it is no longer possible to consider missing the approach if the speed goes below 113 kt or the flaps are extended in 40° position.

In the event of an engine symmetry problem, and more particularly during the flight phases close to the ground, actions must be known by heart and undertaken rapidly. Private pilot recurrent training is not is not sufficiently automatic for the processing of this rare failure. The surprise generated by this failure adds to detection and reaction time.

Choice of landing configuration

The sequence of extending drag inducing elements was dynamic given the rapid deceleration recorded. Extension of flaps to 15°, of the landing gear and flaps to 40° were probably carried out in sequence as the simulation flight demonstrated. The anomaly was detected during the sequence.

The drag induced by extending the flaps to 40 deteriorated performance and contributed to making the speed drop below that recommended by the manufacturer (113 kt). The speed decreased to 90 kt and then became lower than the VMCA approaching the stall speed.

Speed monitoring

The fact of flying with a distinct pitch down attitude in order to return to the ideal glide path must not have encouraged the pilot to significantly increase power to accelerate. Furthermore, the landing configuration opposed any acceleration of the aeroplane. Yet, as soon as he got back onto the glide path, he likely had to increase power significantly again in order to follow it. Analysis of the flight path showed that it was not possible to maintain the glide slope. The asymmetry generated by the increase in power was likely high in this configuration. The lower the speed and the greater the asymmetry, the more control requires high amplitude inputs and significant effort on the controls. The pilot may have had some difficulties in controlling the aeroplane, until he finally lost control. The rate of fall noted on the video as well as the attitude and position of the aeroplane on impact confirms the hypothesis of an asymmetric stall to the right.

After detection of the anomaly, the safest solution offered to the pilot was to maintain a slope enabling him to accelerate to the speed of 113 kt by neglecting the standard glide path evidenced by the glide. This decision was even more difficult to take since the pilot was probably flying with partial external visual references. From that moment on, it was improbable that the aeroplane could reach the runway.

Fixation with the objective

The proximity of the runway threshold, reinforced by the presence of lit approach lights, probably confirmed the pilot in his belief that he had arrived and certainly did not lead him to doubt that he could reach the runway.

Sequence dynamics

The time between initial reduction and the moment when the speed dropped below 90 kt was 40 seconds. During this time, the pilot, the only pilot on board, had to face handling the engine anomaly as well as recovering the glide path in IMC. These actions were carried out at the expense of thorough monitoring of speed. This continued to decrease. It is likely that it was no longer possible for him to accelerate or to consider a missed approach.

2.3 Training

2.3.1 Content of the regulatory training with regard to VMCA

The aim of the training is not to redo a demonstration of the certification leading to the determination of the value of the VMCA but to show the student the behaviour of the aeroplane travelling with maximum asymmetry and to show that the rudder effectiveness has a limit. Consequently this exercise should be carried out with the maximum margin between the VMCA and Vs that's to say in landing configuration and guaranteeing an adequate margin of height in relation to the ground. The use of the simulator must be favoured when it is available.

The regulations in force in Europe at the time of the accident included theoretical and practical courses relating to VMCA. The practical exercises were systematically covered during an exercise simulating a failure on take-off, at maximum power and with increasing speed. The student started by controlling the swerve then the speed by adjusting the climb attitude and then applying the emergency procedure. The importance of a scrupulous respect of the speed on final approach in asymmetric flight was not explicit.

The exercise is different during approach as it requires control of speed by adjusting power whereas the control of the imposed flight path (G/S) is carried out by controlling pitch attitude. This type of exercise is not often carried out during type rating instruction.

If maximum power is necessary when the speed drops below VMCA, then control of the asymmetry can only be carried out by regaining speed at the expense of maintaining the approach path. In this case, the aim point cannot be maintained.

2.3.2 Inappropriateness of the training programme for multi-pilot aeroplanes to complex high performance single–pilot aeroplanes – PART FCL « AIRCREW »

Many aeroplanes included in this category do not have a flight simulator though the programme is constructed so as to be carried out on a simulator and is impossible to undertake on an aeroplane. As an example, item 2.5.2 (takeoff with simulated engine failure between V1 and V2) cannot be performed in complete safety without a simulator. Item 2.5.1 (takeoff with simulated engine failure just after reaching V2) requires immediate feathering or monitoring of the automatic feathering system. This exercise presents no difficulty on the simulator, but on the other hand the failure is systematically reproduced on the aeroplane with a loss of power by reducing the power levers: the gestures are mimed, the power lever positions do not represent reality and the actions are not fully realised. During training, the pilot will never touch the power levers as he would have to do in a real situation.

The regulation does not propose any solution for aeroplanes that have no simulator during approval of training proposed by TRTOs. Thus, the latter do not apply it and do not look for alternative solutions, despite the AMC 2.ORA.ATO.125, which requires that when a type simulator is not available, the ATOs must demonstrate to the competent authority that adequate training is delivered by other means (use of a representative generic simulator, for example).

2.3.3 Training undertaken by the pilot

The pilot had carried out about 15 flying hours with an instructor. Several flights of about two hours between Linz, Lyon and Toulouse were recorded in IFR in the log book in the context of training to obtain type rating. The instructor stated that 2 h 30 of flight was made in VFR.

The regulatory training programme is a minimal programme and that which is actually delivered must be adapted, in particular and that which was in fact delivered has to be adapted, in particular by repeating as often as necessary, the exercises corresponding to those competencies that have been poorly assimilated. However, training organisations can hardly impose training that significantly exceeds the minimum content when it would be necessary and remain economically viable.

The pilot had already obtained a rating on the same aeroplane and was probably at ease. The IFR flight regime is incompatible with most of the handling exercises in the type rating programme.

The pedagogical content of some long trips is difficult to establish, especially when they are carried out in the same day. It would seem that the pilot's professional activity and perhaps ease may have influenced the type of trips planned at the expense of the content of training sessions.

2.4 Unavailability of Information relating to the Number of Persons on Board in the Flight Plan

A query procedure of information in box 19 of the flight plan exists. This procedure is known to the Regional office for flight information and assistance agents but seems unknown to controllers. The query is subject to a manual response from the authority contacted. The reply time may therefore be variable and incompatible with search and rescue operations. This procedure is of course only applicable in the event where a flight plan has been filed. Furthermore, the information in box 19 may differ from the number of persons actually on board and is not binding.

As far as commercial flights are concerned, information relating to passengers is rapidly available from the airline. The same is not true for non-commercial flights.

Like military air traffic authority practices, a systematic request for the number of persons on board by the controller on first radio contact of a non-commercial flight, would make it possible to optimise the SAR function for pilots to benefit from this service by making themselves known.

3 - CONCLUSION

3.1 Findings

- the pilot had the licences and ratings required to perform the flight;
- the fifteen hours logged during the PA31T type rating were recorded as being in IFR on the pilot's log book. Thirteen were carried out on trips of two hours or more;
- the aeroplane had a valid airworthiness certificate. It had just had a scheduled maintenance check during which no engine problems had been noticed;
- the event flight was without incident until the approach;
- the approach was conducted at night in IMC conditions;
- the reduction in speed and the configuration change for landing, gear extended, flaps 40°, took place at a height of about 1,000 feet;
- the pilot detected an anomaly and indicated it on the frequency without specifying its nature;
- the aeroplane's ground speed decreased down to stall speed in this configuration, at low height. It hit the ground with a high bank angle;
- the "*EMERGENCY PROCEDURES*" check-list was found close to the passenger seat, at the "*ENGINE INOPERATIVE PROCEDURES*" page;
- the right engine propeller had not been feathered;
- the right engine was delivering less power than the left engine at the time of impact with the ground;
- a post-impact fire broke out.

3.2 Causes of the Accident

It is likely that during the final approach, a right engine anomaly, detected by the pilot, led to power asymmetry. As a result of a high workload, during the phase of deceleration and gear and flap extension, the pilot likely did not monitor the indicated airspeed, or noted a decrease in it. He may then have encountered difficulties in managing the power asymmetry before losing control of the aeroplane.

The following factors may have contributed to the accident:

- continuation of a fast arrival in a cloud layer, at night to a height of about 1,000 feet before configuring the aeroplane to land, which resulted in a significant increase in the pilot's workload during processing of the anomaly;
- probable fascination with the objective given the proximity of the runway and the attraction induced by the approach lights;
- degraded type rating training to adapt to the pilot's constraints during its renewal;
- absence of specific exercises relating to the conduct of a single engine approach at a speed close to VMCA, in the type rating training for single pilot multi-engine high performance aeroplanes.

4 - SAFETY RECOMMENDATIONS

Note: In accordance with Article 17.3 of European Regulation (EU) 996/2010 of the European Parliament and Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall in no case create a presumption of blame or liability for an accident, a serious incident or an incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken or under consideration, under the conditions described in Article 18 of the aforementioned Regulation.

4.1 Regulation Relating to PART FCL Crew Training

There are three families of aeroplanes for which type rating may be required: single-pilot aeroplanes, complex high performance single-pilot aeroplanes (more than one engine) and multi-pilot aeroplanes. The PART FCL regulation groups together into just one programme the training relating to complex high performance single-pilot aeroplanes and those of multi-pilot aeroplanes. However, this programme was specifically developed to be undertaken through the medium of flight simulators, which are only rarely available for complex high performance single-pilot aeroplanes. Simulation exercises with asymmetric flight can lead to accidents, which fully justifies the use of a flight simulator.

Consequently, the BEA recommends that:

- **EASA evaluate the possibility of developing an alternative programme for complex high performance single-pilot aeroplanes for which there is no adequate flight simulator, for example by using a flight simulator from a similar aeroplane. [Recommendation FRAN-2016-006]**

The exercise for an engine failure for complex high performance single-pilot aeroplanes is common on takeoff but rarely undertaken during approach or landing. These exercises are however different and should be the subject of theoretical and practical lessons for all single-pilot type ratings.

Consequently, the BEA recommends that:

- **EASA reinforce the content of training programmes related to complex high performance single-pilot aeroplanes by integrating exercises on management of asymmetrical flight during approaches with a view to a landing. [Recommendation FRAN-2016-007]**

4.2 Oversight of ATOs

The number of hours of instruction and the rigorous follow-up of the type rating programme approved by the competent authority guarantees a satisfactory level of training. Simple checks on the number of flying hours performed do not make it possible to ensure that all of the training programme has been covered. Thus, performing legs requiring long flights (over 2 hours) or positioning flights, more so when done in IFR, does not enable repetition of handling exercises contained in training programmes. In fact, these flights generally only include a takeoff, an approach and a landing.

Consequently, the BEA recommends that:

- **EASA ensure that the competent authorities from time to time check the equivalence between the exercises included in approved type rating training programmes and the flights that are in fact undertaken in an aeroplane and recorded in the trainee's logbook. [Recommendation FRAN-2016-008]**

4.3 Availability of Information Relating to the Number of Persons on Board

Information relating to the number of persons on board an aircraft can be done by means of a declaration by the pilot when he fills out the flight plan. This information is crucial in case of triggering of search and rescue services, though the conditions of access to the information are not always known.

Consequently, the BEA recommends that:

- **EASA ensure that information on the number of persons on board non-commercial aircraft is quickly accessible, by requiring that the specific field in part 19 of the flight plan be completed and communicated so that the organisations involved can have access to it as soon as the aeroplane takes off. [Recommendation FRAN-2016-009]**

- **The Single European Sky ATM Research (SESAR) programme take into account this type of information in its data systems and make it available. [Recommendation FRAN-2016-010]**

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