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FINAL ACCIDENT REPORT

AVIOARTE SERVIÇOS AÉREOS, Lda

Beechcraft 99

F-BTME

Almeirim Residential Quarter

Évora

14th of August, 2009

GPIAA

Homologo, nos termos do nº 3 do artº 26º do D. L. 318/99, de 11 de Agosto de 1999

2011-07-25

O Director,

Fernando Ferreira dos Reis

FINAL ACCIDENT REPORT Nr. 29/ACCID/2009

NOTE

This report states the technical findings regarding the circumstances and probable causes which led to this accident.

In accordance with Annex 13 to the International Civil Aviation Organisation Convention, Chicago 1944, EU Regulation Nr. 996/2010, from European Parliament and Council, from 20th OCT 2010, and the nº 3 of article 11th of Decree-Law nº 318/99, from 11th AUG 1999, the sole purpose of this investigation is to prevent aviation accidents. It is not the purpose of any such accident investigation and the associated investigation report to apportion blame or liability.

The only aim of this technical report is to collect lessons which may help to prevent future accidents.

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SYNOPSIS

On the 14th of August, 2009, Beechcraft BE-99 aircraft, French registration F-BTME, was performing several parachutists jumping flights, at Évora aerodrome (LPEV). By 17:47 UTC[1] took-off for the last jumping, with one pilot and 12 duly equipped parachutists on board.

When passing 9500ft, climbing to a programmed altitude of 13000ft, aircraft left engine flame-out and eleven parachutists left the aircraft, while the pilot and the other parachutist remained on board and prepared for a single engine landing.

Failing the first approach for landing, the aircraft overflew the entire runway length and the pilot decided to reject the landing, proceeding for a new approach. When power was increased on right engine, for the go-around, the aircraft started to deviate to the left, without regaining altitude, and crashed against a building, near the aerodrome, in Almeirim residential quarter, outskirts of the city of Évora.

The aircraft got fire, after the collision, becoming destroyed and killing both occupants.

GPIAA[2] has been informed of the accident, by 18:20 by Évora aerodrome tower radio operator (AITA[3]), followed by NAV[4], ANPC[5] and PSP[6].

Due the late time of the day, instructions for wreckage preservation were passed and an investigation team travelled to the site, next morning.

This report has been released in Portuguese and English Languages. In case of conflict, Portuguese version will take precedence.

[1] - All timings referred in this report, unless other specified, are UTC (Universal Time Coordinated) timings. By that date, local time in Portugal was equal to UTC + 1 hour.
[2] - Gabinete de Prevenção e Investigação de Acidentes com Aeronaves (Aircraft Accident Prevention & Investigation Authority)
[3] - Aerodrome Information & Traffic Adviser
[4] - Navegação Aérea de Portugal, EPE (Air Traffic Management Provider)
[5] - Autoridade Nacional para a Protecção Civil (National Civil Protection Authority)
[6] - Polícia de Segurança Pública (Public Security Police)

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft, a Beechcraft model BE-99, s/n U79, with French registration F-BTME, belonging to the operator "Avioarte Serviços Aéreos, Lda", was involved all that day, 14th of August, 2009, flying locally, carrying parachutists for skydiving exercises, in the vicinity of Évora aerodrome (LPEV), working for the enterprise "Skydive".

With twelve full equipped parachutists and one pilot on board, the aircraft took-off on runway 01 at 18:47, intending to climb to an altitude of 13000ft (4000m), at which altitude the jumping would take place.

When passing about 9500ft (2900m), left engine (#1) flame-out and respective propeller was automatically feathered. The pilot stop climb at around 10500ft (3200m), informed the parachutists that one engine had stopped and they should jump a little lower than it was expected, while he would proceed for landing at same aerodrome, with one engine inoperative.

All parachutists left the aircraft, on sequence, but one, who, after being next to the exit, returned to the cockpit and remained on board, with the pilot.

The aircraft started a dive, turning around the field, and the pilot contacted the tower on left base leg for runway 01, but said nothing about the inoperative engine or any assistance required. He was told to report on final, which he never did.

He continued the approach for runway 01, with landing gear down and flaps at initial setting (13º), but keeping high speed. The aircraft made a low pass, over all runway length, without the wheels touching the ground. Once passing runway end it continued flying, the pilot increased power on right engine (#2) and the aircraft started deviating to the left, with wings levelled and without showing significant climb tendency.

Observers, at the aerodrome, lost the sight of the aircraft for some moments and saw it reappearing close to Almeirim residential quarter (in the outskirts of Évora).

One testimony, sited at the aerodrome, referred seeing the aircraft executing a sudden manoeuvre, like a left roll, pointing the wheels up to the sky. Moments later a collision sound was heard, the engine became silent and some flames and a black smoke cloud appeared.

The aircraft collided with a residential building, in Maria Auxiliadora street, Almeirim residential quarter, sited about 1160m far from runway end, on track 330º (*picture nr 1*). After the collision with the building, the aircraft fell to the ground, upside-down, a fire sparked immediately and the plane was engulfed by flames.

Fire brigades from Évora, Viana do Alentejo, Montemor-o-Novo and Arraiolos arrived at the scene, promptly, but it took some time for the fire to be extinguished (after burning all aircraft fuel) and the burned bodies recovered from the wreckage.

Picture Nr 1

1.2 Injuries

Both occupants, who remained on board, suffered fatal injuries. The other eleven passengers, who jumped in flight, were unhurt (*table nr 1*).

Injuries	Crew	Passengers	Others
Fatal	1	1	0
Serious	0	0	0
Minor/None	0	11	0
Total	**1**	**12**	**0**

Table Nr 1

1.3 Aircraft Damage

The aircraft has been destroyed and consumed by fire (*picture nr 2*).

Picture Nr 2

1.4 Other Damage

Three apartments had been damaged by the aircraft collision and the fire that sparked after, together with other residence's problems related to the electric power cut, specially for freezers and refrigerators. The owners of the apartments were out, on holidays, being the street free of cars and no people were at home, minimizing third party damage and liabilities.

1.5 Persons Involved

1.5.1 Pilot

The aircraft was flown by only one pilot (the owner), male, Portuguese nationality, 39 years old. No pilot licence was found and Portuguese Civil Aviation Authority (INAC) reported there was no registry of the pilot concerned, who never asked or had been entitled with a Portuguese Flying Licence.

Assisted by United States of America NTSB, it was possible to trace that the pilot followed a Private Pilot Course with an American flying school, in Florida, getting a PPL(A), issued by American FAA on 17-JAN-2009, valid for single engine propeller aircrafts, under 12500Lbs (5700kgs). Last medical refers to a class 3 certificate, issued on December 2008, by USA Authority. Later he contacted the same flying school in order to follow a multi engine pilot course, which he never started.

No flying registry was found, so it was impossible to quantify pilot's flying experience. The only information was got from French insurance company "Aélea" to whom he declared (the

4th of August, 2009) the total amount of more than 400 hours, being 300 on single engine, on Cessna 208B (Caravan) and 50 on Beechcraft 99 (multi-engine).

Where he got those BE-99 50 hours experience could not be ascertained. The only information is that he flew twice this aircraft, in France, when he bought it from French owner, who declared that no special manoeuvres, including engine failures, were performed, as they trusted pilot declared information on his qualifications and experience.

1.5.2 Passengers

There were twelve passengers on board the aircraft, all of them parachutists (instructors & students), who intended to jump from an altitude of 13000ft (4000m). Due the left engine failure, they jumped at a lower altitude and landed safely, except one, who remained on board with the pilot.

1.6 Aircraft

1.6.1 General

It was a twin engine land aircraft, single low wing, metallic construction, retractable tricycle landing gear (*picture nr 3*), with a Maximum Take-Off Mass (MTOM) of 10400Lbs (4717kg) and seating 17 people, with following references (*table nr 2*):

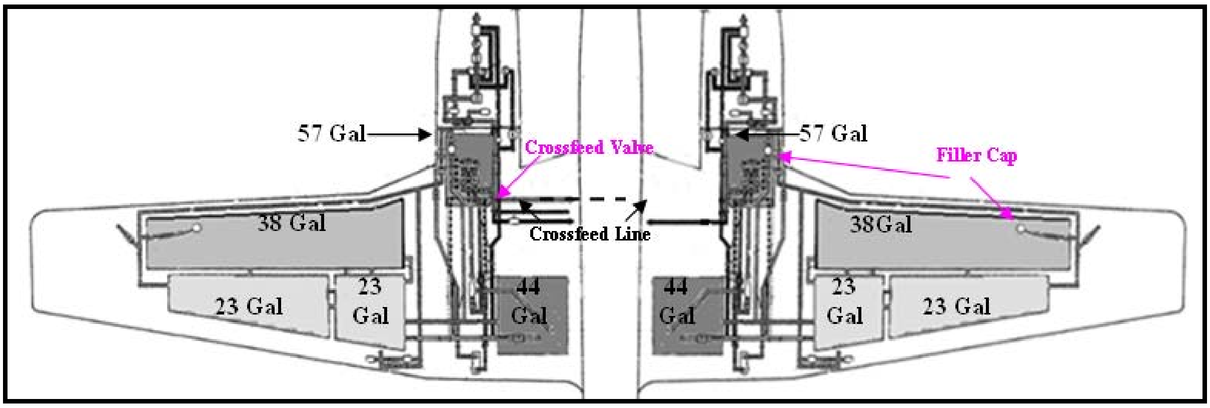
Picture Nr 3

Reference	Airframe	#1 Engines #2	#1 Propellers #2
Manufacturer:	Beech Aircraft Corp.	Pratt & Witney Canada	Hartzell
Model:	BE 99	PT6 A 20	HCB3TN3B
Serial Nr:	U79	PCE 21733 - PCE 21360	EUA 22020 - EUA22522
Flight Hours*:	22993.61	23637.63 - 10835.52	N/D
Landings/Cycles*:	17449	44693 - 10065	N/D
Last Inspection:	29-07-2009	29-07-2009	29-07-2009
* - All these values are reported to last inspection date – 29-JUL-2009.			

Table Nr 2

1.6.2 Fuel System

Being a twin engine, Beechcraft 99 aircraft was equipped with two independent fuel systems, one on each wing, with a capacity of 185USG (700litres) each, interconnected by a cross-feed line with respective operating valve, situated in left engine nacelle, making a grand total of 370USG (1400litres), usable by anyone of the engines.



Picture Nr 4

Each fuel system was composed by five fuel cells, interconnected, being three in outer wing area, one in inner wing area, and the other in the engine nacelle (*picture nr 4*). All of them debited into nacelle tank, by gravity, which fed respective engine, directly, or the other engine, through crossfeed line, when crossfeed valve was opened. By design, there were 28USG in each wing that couldn't be used, as they couldn't flow to nacelle tank.

Refuelling was done by gravity through two filler caps on each wing, one in the nacelle tank and the other in wing leading edge tank.

Tanks were cross-vented and connected to the atmosphere by a recessed vent coupled to a static vent in the underside of each wing, adjacent to the nacelle.

Fuel quantity indication was provided by capacitance probes embedded in every cell and shown in two indicators, situated in cockpit forward pedestal, showing total usable fuel quantity in each wing (*picture nr 5*).

A crossfeed valve actuation switch, situated below quantity indicators (*picture nr 5*), allowed any engine to be fed with fuel from any wing tank, opening crossfeed valve, situated in left engine nacelle, and allowing fuel transfer from one wing to opposite engine.

Figura Nº 5

1.6.3 Equipment

The aircraft was owned by a French transport company and recently bought by "**Avioarte Serviços Aéreos, Lda**" to reinforce its fleet, used for parachute jumping on behalf of "**Skydive**" enterprise. In order to facilitate the operation, all passenger cabin seats have been removed and main door replaced by a screen door, more fit for this kind of operation, as it was possible to be opened in flight and it could remain opened without heavy penalty to aircraft performance.

1.7 Meteorology

Even if there was an automatic meteo station in the vicinity of the aerodrome, its information was not available for pilots operating from or to LPEV. Checking its records it was confirmed that the sky was cleared in the morning, becoming partially clouded by afternoon, with few clouds at 3500ft, after 14:00. By the time the accident happened, the visibility was good and the wind from 120º with 5kts, maximum 10kts. It was a typical summer day with 36ºC temperature, due point 8ºC with18% humidity (*table nr 3*).

Redondo, Alentejo Central, Portugal — Current Conditions

Daily Summary for Agosto 14, 2009

Time	Temp.	Due Point	Pressure	Wind Direction	Wind Speed	Wind Gust	Humidity	Rainfall Rate
17:51	36.1 °C	8.0 °C	1013.4hPa	ES-NORDESTE	4.8km/h	16.1km/h	18%	0.0mm
17:56	36.0 °C	8.0 °C	1013.4hPa	NOR-NORDESTE	8.0km/h	16.1km/h	18%	0.0mm
18:01	36.0 °C	8.0 °C	1013.4hPa	ES-NORDESTE	12.9km/h	14.5km/h	18%	0.0mm
18:06	35.9 °C	7.9 °C	1013.4hPa	ES-SUDESTE	12.9km/h	16.1km/h	18%	0.0mm

Table Nr 3

1.8 Navigation Aids

Not applicable.

1.9 Communications

The aircraft was equipped with two-way radio communications and the pilot made regular contacts with the tower, but never referred being in distress, with an engine inoperative, nor asked for any kind of assistance.

1.10 Aerodrome

1.10.1 General

Located at coordinates 38º 32’ 49” N / 007º 53’ 30” W and an altitude of 807ft (246m) Évora Municipal Aerodrome belonged to the Portuguese domestic aerodromes’ network and it was available for VFR traffic of aircrafts with a MTOM ≤ 12500Lbs (5700kgs), during daytime or during the night by request. It was served by a tarmac main runway with 4265ft X 75ft (01/19) and a grass runway with 2100ft X 100ft (08/26). There was a 1500ft X 165ft aircraft parking area, with taxiways for runway access on both tops of the apron (*picture nr 6*).

Picture Nr 6

There was no air traffic control service but only an aerodrome information and traffic advisory service, provided by an AITA, present in the Tower during normal aerodrome operating hours.

Main runway, taxiways and apron were equipped with a lighting system and there was a Visual Approach Light System (PAPIS) installed on both runways, with an approach light system for RW 19, only.

Even considering there were several aeronautical activities, based at the aerodrome, there was no Emergency & Fire Fighting Services in the field, relying on nearby Fire Fighting Departments (Évora and Viana do Alentejo) or from vicinity towns (Arraiolos, Montemor-o-Novo, etc). In the field, only some fire extinguishers loaded on a light truck and the minimum personnel to operate them were available.

There were fuelling facilities (Gasoline, Avgas & JetA1) and maintenance support for light aircrafts.

1.10.2 Parachute Jumping Activities

In face of the excellent climate conditions of that place, the aerodrome was chosen for installation of a flying academy and several aeronautical activities' enterprises like general aviation & ultra light pleasure flying, gliding, parachuting and air work (the first ones to be established there).

Ultimately, parachuting was so popular that a NOTAM (A4243/08) covering this activity all year round, was issued (*picture nr 7*).

PARACHUTE JUMPING EXERCISES WILL TAKE PLACE ON AREA:
RADIUS 8NM CENTERED ATP 383247N0075330W - EVORA AD.
ACTIVITY MUST BE PREVIOUSLY COORDINATED WITH BEJA APP FREQ 130.10MHZ
OR LISBOA INFORMATION FREQ 123.75MHZ (TELEPHONE 210406462.
LOWER: GND
UPPER: FL160
A4243/08
FROM: 02 JAN 2009 08:00 **TO:** 27 DEC 2009 17:18
SCHEDULE: FRI SAT SUN 0800-SS FEB 10 11 12 16 17 18 19 23 24 25 26 MAR 02 03
04 05 APR 06 07 08 09 13 14 15 16 MAY 25 26 27 28 JUN 01 02 03 04 08 10 11 29
JUL 06 07 08 09 13 14 15 16 OCT 05 DEC 01 08 0800-SS

Picture Nr 7

1.10.3 Complementary Information

Due Évora city proximity, classified as "World Heritage", regarding inhabited zones protection, some limitations were imposed to local flying operations - Manual do Piloto Civil (MPC)[7], issued by INAC, cap. AGA 2-12 (*picture nr 8*).

15. INFORMAÇÕES COMPLEMENTARES

- Procedimentos a cumprir nas saídas e entradas de/para o Aeródromo:
  - Aterragens na pista 01 – é obrigatório o circuito direito;
  - Aterragens na pista 19 – é obrigatório o circuito esquerdo;
  - Descolagens na pista 01 – proibido voltas à esquerda;
  - Descolagens na pista 19 – proibido voltas à direita;
  - Aos Sábados, Domingos e Feriados deverá ser evitado o sobrevoo do aeródromo;
  - Para voos com entrada por Oeste, prosseguir directamente pelo Sul do aeródromo para uma final longa da pista 01 e aterrar ou, caso seja a pista 19 em uso, prosseguir dessa final para o vento de cauda esquerdo.
  - Na área de aproximação da pista 01, tomar atenção a duas vedações de arame, uma a cerca de 60 m da soleira e outra a cerca de 300 m, em local elevado sobre a mesma soleira, com cerca de 1,5 m de altura
  - Actividades habituais ao fim de semana e feriados: planadores e pára-quedismo, num raio de 3 km, com centro no Aeródromo, até à altura de 2000 metros AGL.
- Procedimentos Anti-Ruído nocturno e até às 0900h locais.
  - Só são permitidos neste período run-ups no Taxiway Sul
  - Expressamente proibidos voos sobre a Cidade e a Oeste da Pista.
  - Descolagem na Pista 01, aos 500 pés AGL, voltar à direita para o circuito ou voltar à direita no rumo 090 e só depois dos 3000 pés voltar para o rumo de saída.
  - Descolagem na Pista 19, aos 500 pés AGL, voltar à esquerda para o circuito ou subir no rumo da Pista e só depois dos 3000 pés, voltar para o rumo de saída

INSTITUTO NACIONAL DE AVIAÇÃO CIVIL 03.07.09

Picture Nr 8

1.11 Flight Recorders

The aircraft was not equipped with flight recorders.

1.12 Wreckage & Impact

From on site examination it was determined that the aircraft collided with the apartments' building in a position very close to inverted flight. Left wing was the first to hit the roof, where the wing tip was detached, and continued sliding down along the wall till the ground (*picture nr 9A*).

[7] - This publication (Civil Pilot Manual) has been replaced by VFR Manual, since March 2010.

Figura Nº 9

Collision with the ground happened with aircraft upside down and nose slightly down, facing the building. Left engine separated from the wing and left propeller collided with a residence wall, due shaft fracture (*picture nr 9B*).

Aircraft nose and right power plant impacted nearby, against a column, the propeller separated and rested under the wreckage, which was upside down, on the street (*picture nr 10*).

Figura Nº 10

The fuselage, right wing and right engine nacelle were totally burnt by fire, becoming calcinated, while left inner wing and left engine nacelle were only partially burnt. The tail and left outer wing were spared from fire (*picture nr 10*).

Flaps were found selected to initial approach position (≈ 13º). Ruder trim, stabilizer and aileron trim were found in neutral position. Landing gear was in extended position with pneumatics unpressurized, left main wheel apparently normal, right main wheel burnt and nose wheel calcinated by fire (*picture nr 11*).

Picture Nr 11

Complete destruction and calcination of switches and levers, in the cockpit, prevented to determine their positions on impact.

1.13 Medical or Pathological

Both, the pilot and the passenger on board, suffered multiple fractures and injuries on their heads, thorax (fractured ribs and internal organs rupture with hemotorax) and upper & lower limbs, serious enough to cause the death. Further more, their bodies suffered first and second degree burns, with carbonization of some parts.

1.14 Fire

Immediately after collision, sparked a fire that consumed almost the entire aircraft, before the firemen could extinguished it, with the application of fire foam.

1.15 Survival Aspects

Considering the violence of the impact and the seriousness of the injuries suffered by the occupants, it was considered they had no chances of survivability, even if the aircraft didn't caught fire and immediately assistance could be provided.

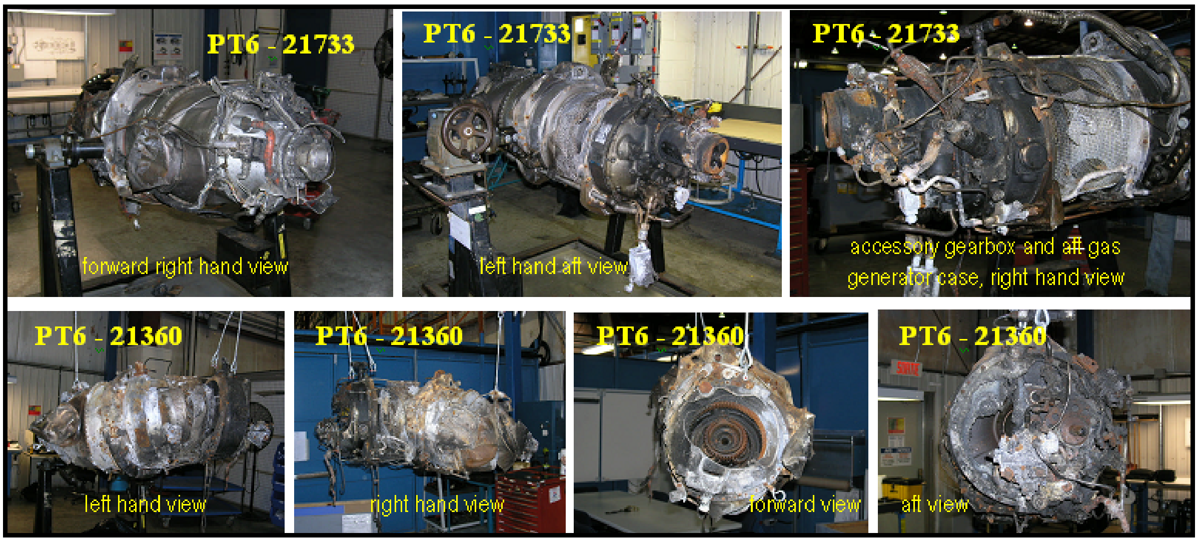
1.16 Tests & Research

1.16.1 Airframe

In face of the destruction status of the aircraft and the fact that fire consumed the majority of the wreckage it was impossible to progress with specific examinations, specially considering that a great amount of parts were calcinated and became destroyed by touch. So, it was not possible to acknowledge the position of engines & propellers' control levers, gear selector, flight controls, fuel selectors and all switching.

1.16.2 Engines

Left engine (s/n 21733) separated from the wing, due impact forces, becoming partially burnt. Different happened to the right one (s/n 21360), which became almost calcinated by fire (*picture nr 12*).



Picture Nr 12

In order to determine the probable cause of left engine sudden stoppage, it was sent to the manufacturer, Pratt & Whitney Canada, where a full inspection was carried out. By insurer suggestion, right engine's wreckage, which was running at full power at impact, was also sent for examination.

Engine inspection was performed by manufacturer experts (PWC) supervised by Canadian Air Accident Investigation Authority (TSB). Not only main engine parts were investigated but also engine controls and other accessory units, which could be disassembled.

From that final report the most significant conclusions, for accident evaluation, were withdrawn and shown bellow:

a) **Engine nr 1 (s/n 21733) –** *it "displayed contact signatures to its internal components characteristic of the engine being unpowered and rotating under air loads at the time of impact. The static contact signatures of the power section were characteristic of the propeller being most likely in feather at the time of impact. There were no indications of any pre-impact mechanical anomalies or dysfunction to any of the engine components observed that would have precluded normal engine operation and full power output"*;

b) **Engine nr 2 (s/n 21360) -** even considering its calcination status, preventing its dismantling (some parts had to be mechanically separated), *"the right engine displayed contact signatures to its internal components characteristic of the engine producing power at the time of impact, likely in a high power range"*.

1.16.3 Documentation

Aircraft documents should be on board, in folders that were destroyed by fire and fire extinguishing agents, comprising aircraft & engines' history till the moment the aircraft was sold to the last owner.

After aircraft delivery and its travel to Portugal, no maintenance works were performed and no flight registries were found, except Évora aerodrome movements (take-off & landings) related to the period between the 10th and the 14th of August, 2009, provided by aerodrome authority. From Portuguese Air Traffic Management Authority it was possible to get information on some Flight Plans (FPL) submitted from the 5th to the 14th of same month.

Analysis of that information confirmed that, at least, 20 flights were performed, involving a minimum of 07H10. Considering that there was no continuity on FPL, with some aerodromes' connecting flights missing, we may take for sure that the aircraft performed more flight hours than those referred above.

No refuelling receipts were found, but two from Évora fuelling station, relating to 10 and 11 of August, when it was refuelled 92.5USG (350litres) and 30USG (112litres), respectively. Considering that the aircraft left Évora on the 11th of August, returning on the 12th, nobody knows if and how much fuel was loaded outside this aerodrome. In other way, there were some declarations informing the pilot used to refuel his aircrafts from private containers, carried by himself. In such a case it was impossible to quantify the total amount of fuel on board, not only at take-off time but at impact time as well. The same relating the distribution of fuel for both wings, Even so, we may consider the left wing tanks should be empty, at impact, as this wing didn't caught fire, in spite of the rupture of the fuel cells installed.

1.17 Organizational & Management

The operator, "***Avioarte Serviços Aéreos, Lda",*** was registered as an air transport enterprise, on commercial registry, but no Air Operator Certificate (AOC) or Air Work Operator Certificate (AWOC) has been issued by Portuguese Civil Aviation Authority (INAC).

The aircraft had been bought recently (it was in the country for about a week) and there was no request for a Portuguese registration, flying with its original French registration. The same operator had another aircraft, operating in Portugal for more than a year, with a USA registration.

Both aircrafts were used for parachuting, on behalf of another enterprise, ***"Skydive",*** belonging to the same owner.

No Flight Operations Manual and/or Maintenance Manual were found, being no maintenance agreement signed with any maintenance provider.

1.18 Additional Information

There's no other relevant information to refer.

1.19 Special Investigation Techniques

No special techniques were used for this investigation.

2. ANALYSIS

2.1 Flying Twin Engine Aircrafts

2.1.1 Classification

Considerations presented bellow, adapted from FAA publication "*Airplane Flying Handbook*", refer to small multiengine airplanes, assuming they are propeller powered aircrafts equipped with two engines, one on each wing, with a Maximum Take Off Mass (MTOM) of 12500Lbs (5700kgs) or less, as it was the aircraft involved in the accident.

2.1.2 Main Differential Characteristics

This is not an intensive study on twin aircraft's operation, but only a reference to the main differences found when transiting from a single to a multiengine airplane, especially when an engine failure occurs.

Unless this is the main difference between them, there are other important differences, which the pilot should consider, but will not be referred in deep on this study.

From all main differential characteristics between single and multiengine we may refer:

a) Multiengine exclusive Reference Speeds, especially when operating with one engine inoperative (V_1, $Vx_{(SE)}$, $Vy_{(SE)}$, $Vs_{(SE)}$, Vmc)[8];

b) Propellers with feathering capacity and synchronization systems;

c) Fuel transfer (crossfeed) in order to allow fuel feeding any engine with fuel from the opposite wing tanks;

d) Windscreen cleaning and ice protection systems;

e) "Yaw damper" and other flight controls' related systems.

Because engine failure is the most penalizing situation for this kind of airplanes and the one that demands a greater pilot proficiency, only this multiengine characteristic will be consider for this short study.

2.1.3 Asymmetric Flight

2.1.3.1 Engine Failure

The failure of one engine, on a twin-engine aircraft, represents the loss of 50% of available power, which causes 80% to 90% or more of climb capacity reduction, depending on total mass and balance of the aircraft and atmospheric conditions prevailing.

[8] - **V1 –** Decision Speed, in case of engine failure, to reject or to continue takeoff;
Vx(SE) - Best angle of climb Speed, with one engine inoperative;
Vy(SE) – Best rate of climb Speed, with one engine inoperative;
Vs(SE) – Stall Speed, with one engine inoperative;
Vmc – Minimum control Speed, with one engine inoperative.

According the moment of engine loss, the seriousness of the situation varies. If the engine fails during takeoff it will be more critical than if it fails in flight, or even during the approach for landing phase.

2.1.3.2 Single Engine Flight Principles

First pilot action, when an engine fails, is to keep control of the airplane and continue to fly safely. For this, he must take in account that:

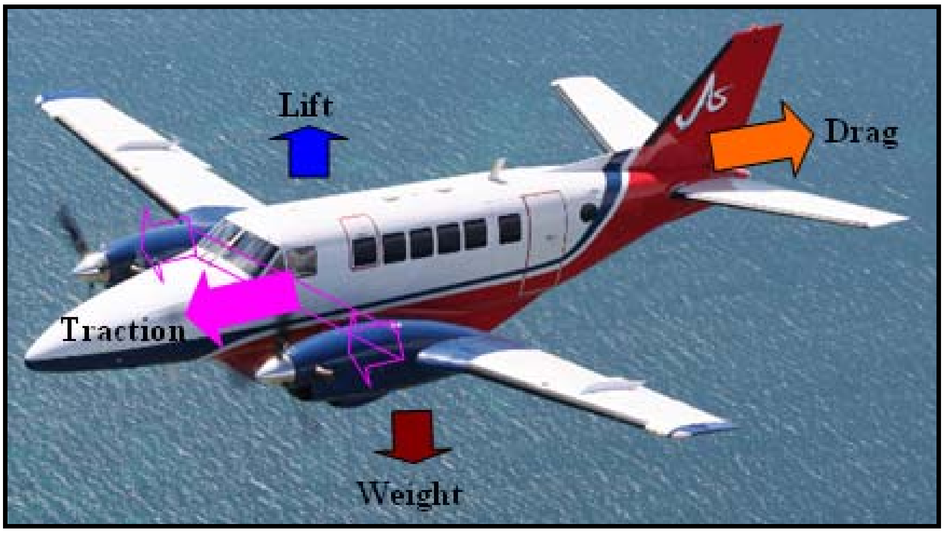
1. The airplane tends to deviate to the side of the inoperative engine and directional control should be maintained;
2. Climb capacity is heavily penalized and speed starts to reduce, becoming necessary to maintain a minimum control speed (Vmc) and avoid altitude loss, especially if the aircraft is close to the ground;
3. Propeller rotation, without traction, increases drag and reduces airplane flying capacity, requiring to feather it to minimize drag;
4. If the flight has to be continued for a significant time, fuel consumption from same side may create fuel asymmetry in tanks, being convenient to open the crossfeed to avoid great asymmetry;
5. In case it's necessary to continue climb to a minimum safety altitude, the best climb performance is achieved using maximum continuous power on operating engine and best rate of climb speed ($Vy_{(SE)}$), or, having to overpass a close obstacle, using maximum angle of climbing speed ($Vx_{(SE)}$).

In all situations, it's essential to reduce drag as much as possible, for what, after retracting landing gear and flaps, attention should be given to flight controls position, in order to expose a minimum profile, avoiding airplane sideslip, controlling flight direction and reducing drag.

2.1.3.3 Twin Engine Aerodynamic Behaviour

Under normal operating conditions, with engines' symmetrical power, a twin-engine reacts like a single-engine, relating to the four basic forces. Traction balances drag, while lift opposes weight. On a twin, traction is obtained from two engines, each one installed on each wing. In order to avoid the airplane to deviate to one side, power on both engines should be kept at equal values during the flight. The use of synchronizer systems enables to minimize propellers' resonance, reducing noise level.

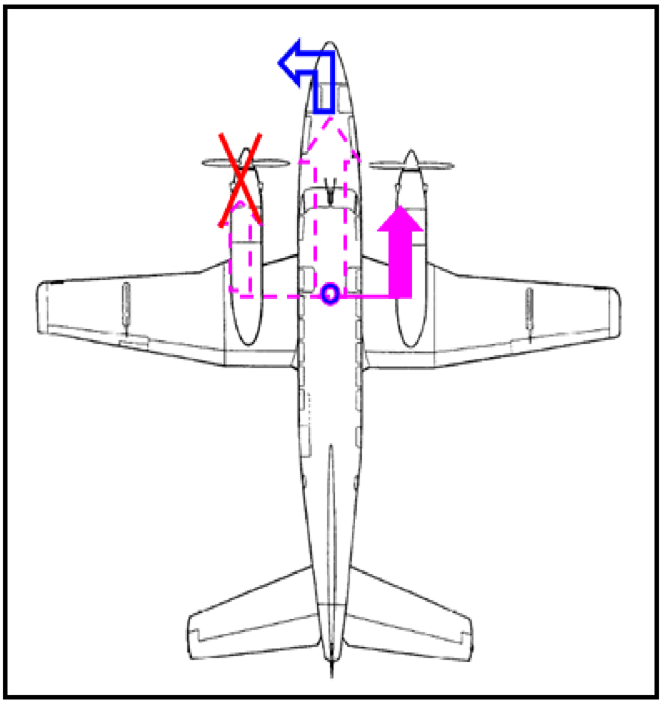
Being traction force the result of two different forces applied at symmetrical points, regarding the aircraft longitudinal axe, it may be represented by one sole vector equal to the summation of both forces, situated on longitudinal plan and applied at the mean point (*picture nr 13*).



Picture Nr 13

When the engine fails, on a single-engine, all power (traction) is lost but there is no yaw movement, being the balance restored by decomposition of weight into two forces (*progress* - to counter-act drag and *weight* - opposing lift), keeping a minimum speed by exchange for altitude loss (*picture nr 14*).

Picture Nr 14



Picture Nr 15

By the contrary, when an engine fails on a twin-engine, an unbalance is created, which causes a yaw movement of the aircraft to the side of inoperative engine (*picture nr 15*).

If this yaw movement is not immediately controlled, it will cause a wing drop, on the side of inoperative engine, due lift increase and consequent rise of opposite wing, with the aircraft entering a spiral dive, which may conduct to a control loss.

In other way, keeping altitude and wings levelled, once power was reduced to one half, speed will start reducing and, if no adequate measures are taken and corrected procedures followed, the speed can reduce well bellow $V_{S(SE)}$ and the airplane stall.

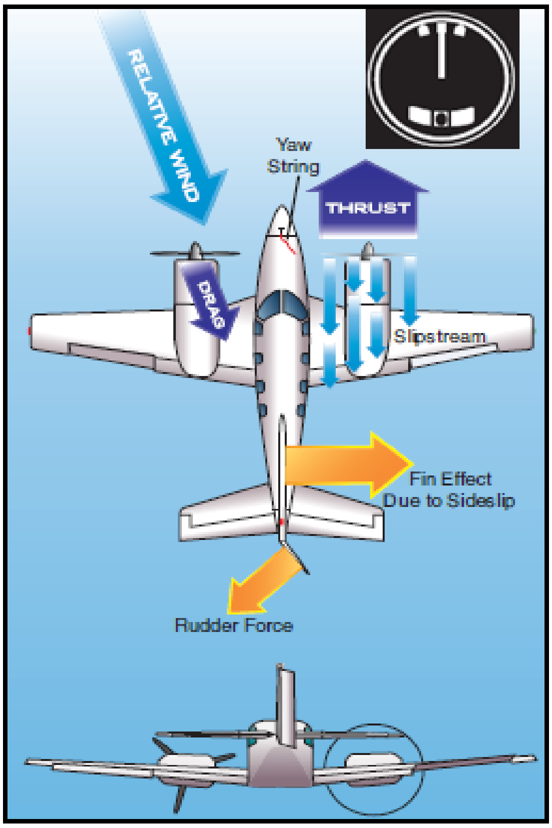
2.1.3.4 One Engine Inoperative Directional Control

There are two different control inputs that can be used to counteract the asymmetrical thrust of a failed engine:

(1) yaw from the rudder;

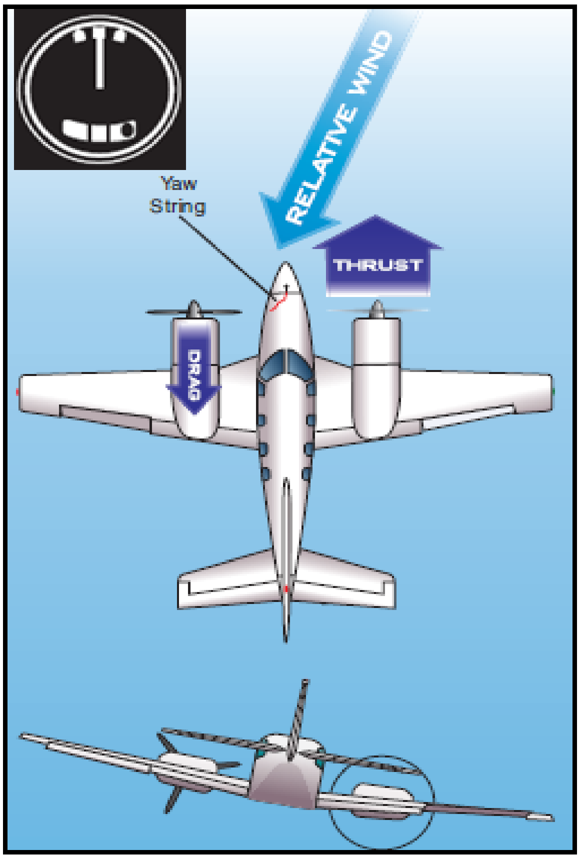
(2) the horizontal component of lift that results from bank with the ailerons.

Three different scenarios of airplane control inputs are presented below. **Neither of the first two is correct**. They are presented to illustrate the reasons for the zero sideslip approach to best climb performance[9].



Picture Nr 16

Keeping wings levelled, it's possible to maintain track applying ruder to operating engine side. This needs a great ruder deflection, acting against vertical stabilizer effect, creating a side-slip to the side of dead engine and substantially increasing drag (*picture nr 16*).



Picture Nr 17

If, by the contrary, ruder is kept in neutral and only aileron is used to keep straight flight, a great aileron deflection is required (8º to 10º bank) causing a substantial drag increase and a sliding of the airplane to operating engine side, resulting in a greatly reduced climb performance (*picture nr 17*).

The best way to grant a straight & level flight, without side slipping, with a minimum drag and consequently with a better climb performance, is the coordinated application of both controls, aileron and ruder (*picture nr 18*).

[9] - Information and pictures illustrating this chapter were taken out from FAA publication "Airplane Flying Handbook".

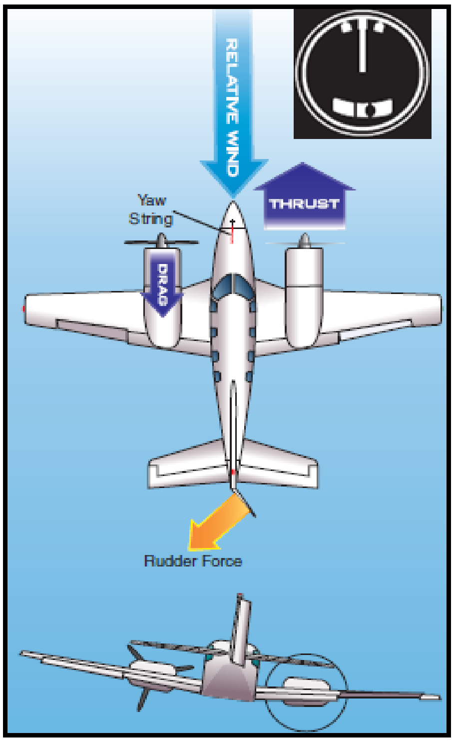


Figura Nº 18

Rudder and ailerons used together in the proper combination will result in a bank of approximately 2° towards the operative engine (maximum recommended 5º). The ball will be displaced approximately one-third to one-half towards the operative engine. The result is zero sideslip and maximum climb performance. When bank angle is plotted against climb performance for a hypothetical twin, zero sideslip results in the best (however marginal) climb performance or the least rate of descent.

Once the aircraft is controlled and stabilized, the pilot should trim all flight controls in order to have a more soft flight and reduce pilot load, allowing more attention to other flight tasks, namely navigation accuracy and appropriate checklist accomplishment, including those necessary to try to restart the failed engine.

2.1.3.5 One Engine Inoperative Speed Control

One engine loss, on a twin-engine airplane, doesn't necessary imply that the airplane is unable to maintain altitude, or even climb, using remaining power available. However, it's essential to consider aircraft performance when its speed falls near single engine stall speed ($V_{S(SE)}$) and/or single engine minimum control speed (Vmc). Both these speeds values are provided by the manufacturer and represent the minimum speed at which the plane can fly safely. Any manoeuvre that puts the aircraft bellow these speeds will cause the loss of its flying capacity and will end in accident.

$V_{S(SE)}$ is the safe, intentional, one-engine-inoperative speed. It doesn't change with altitude but is dependent of aircraft configuration.

Vmc is the minimum control speed with the critical engine inoperative. The minimum speed at which directional control can be maintained under a very specific set of circumstances, namely:

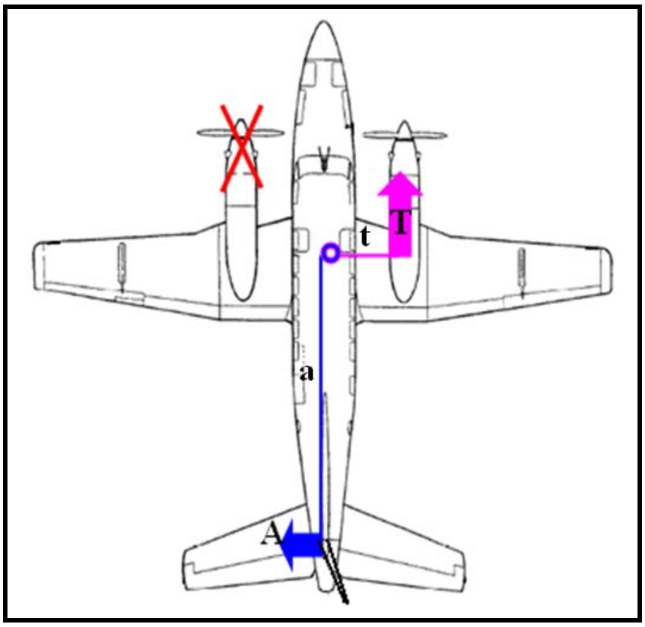
(1) the flight test pilot must be able to stop the turn that results when the critical engine is suddenly made inoperative within 20° of the original heading, using maximum rudder deflection and a maximum of 5° bank;

(2) thereafter, maintain straight flight with not more than a 5° bank.

It decreases with altitude and depends from engine power, ruder area & deflection angle and respective positions relating aircraft centre of gravity.

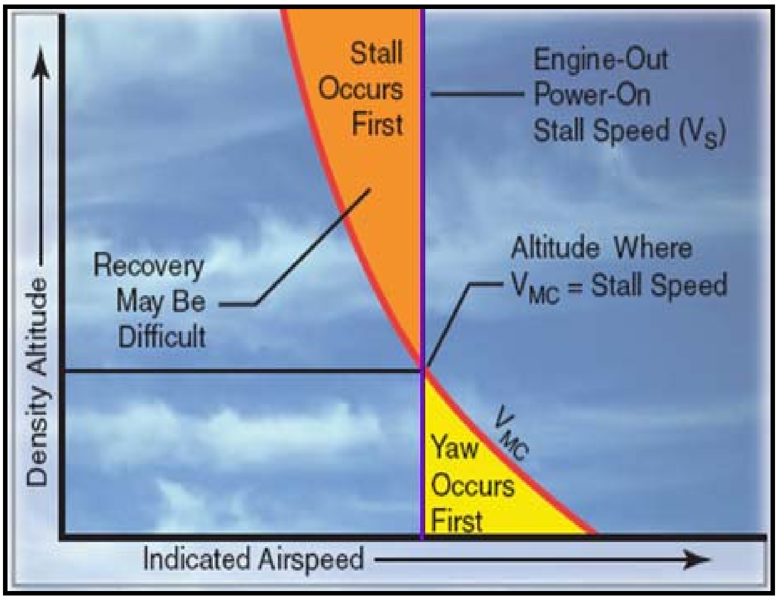
To maintain straight flight, with one engine inoperative, aerodynamic force "**A**" multiplied by its arm "**a**" must counter-act engine power "**T**" multiplied by its arm "**t**" (*picture nr 19*), being force "**A**" dependent of vertical aerodynamic profile (fin and ruder) and aircraft airspeed.

Vertical aerodynamic profile is defined by design and attains its maximum efficiency at ruder full deflection. For the same ruder deflection aerodynamic force "**A**" varies directly with airspeed.



Picture Nr 19

When airplane speed falls bellow Vmc, aerodynamic force (A x a) can't balance engine force (T x t) and the aircraft starts deviating to inoperative engine side, without the pilot having control, unless he increases speed (by altitude trading) or reduces engine power.



Picture Nr 20

The chart (*picture nr 20*) shows inter-relation between these two speeds and illustrates the critical flight conditions (stall & yaw) developed when the airplane speed enters overlapping areas, where one condition rapidly takes to the other.

When an aircraft enters yellow area, at low altitude, it's quite impossible to recover control and avoid ground collision.

In one engine inoperative flight at low altitudes and airspeeds, such as the initial climb after takeoff (or go-around), pilots must operate the airplane so as to guard against the three major accident factors:

(1) loss of directional control;

(2) loss of performance;

(3) loss of flying speed.

2.1.3.6 One Engine Inoperative Approach & Landing

The approach and landing with one engine inoperative is essentially the same as a two-engine approach and landing. The traffic pattern should be flown at similar altitudes, air-speeds, and key positions as a two-engine approach. The differences will be the reduced power available and the fact that the remaining thrust is asymmetrical. A higher-than-normal power setting will be necessary on the operative engine.

Pilot has to keep the airplane controlled and on trim, on correct speed (recommended by the manufacturer), extend landing gear in usual sequence and select flaps to an initial position (generally 10º) until base leg, when an intermediate position (25º) may be selected, avoiding significant speed and attitude variation. Depending on the situation, landing can be performed with an intermediate flap setting or full flaps. In this case they must be selected only when landing is granted.

On final approach, a normal, 3° glide path to a landing is desirable. VASI or other vertical path lighting aids should be utilized if available.

The airplane should remain in trim throughout. The pilot must be prepared, however, for a rudder trim change as the power of the operating engine is reduced to idle in the roundout just prior to touchdown. With drag from only one windmilling propeller, the airplane will tend to float more than on a two-engine approach.

Single-engine go-arounds must be avoided. As a practical matter in single-engine approaches, once the airplane is on final approach with landing gear and flaps extended, it is committed to land. If not on the intended runway, then on another runway, a taxiway, or grassy infield. The light-twin does not have the performance to climb on one engine with landing gear and flaps extended.

In the event a go-around can't be avoided special attention should be given to speed (never let it fall bellow $V_{y(SE)}$), be prepared to counter-act the yaw effect generated by asymmetrical power, retract gear as soon as possible and flaps on speed schedule and at safety altitude, as recommended by the manufacturer.

During this manoeuvre it's easy to fall on critical area (bellow Vmc), that's why the approach should be performed on, or above, recommended approach speed (V_{REF}), in order to maintain directional control during go-around.

2.1.4 Training

In view of the above considerations, it's easy to infer the need to follow a duly organized and comprehensive training programme, before passing from a single-engine to a multi-engine airplane flying.

Aircraft complexity, special flying characteristics and more complex systems installed, requiring detailed operation knowledge, are strong enough reason for the official requirement to get a special qualification before being allowed to pilot a multi-engine airplane.

2.2 Flight Planning

It was not possible to collect relevant information, relating the preparation of that day flights, except the ATC Flight Plan submitted to competent ATM authorities (*picture nr 21*).

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140946 LPPCZFZX (FPL-FBTME-VG
-BE99/L-S/C
-LPEV1010
-N0120F130 LOCAL
-LPEV0015 LPBJ
-OPR/PVT RMK/LANCAMENTO DE PARAQUEDISTAS VARIOS VOOS ATE SS)
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Picture Nr 21

Several testimonies refer the pilot used to fly successive legs, with a minimum interval, without shutting-down the engines. After the last parachutist jumping he used to enter a dive, with throttles closed, flying around the field and entering a high speed/high descent rate base leg for landing, in order to be on ground when the parachutists landed and picking them up for another ride. It's acceptable he used the same procedure on that day, being the event flight the 6th sortie of that day.

2.3 Flight Progress

After five other sorties, the aircraft took-off from runway 01, by 18:47, carrying on board one pilot and 12 parachutists (students and instructors), climbing in turn, inside aerodrome traffic zone, expecting to start jumping at 13000ft altitude.

Climbing through 9500ft, approximately, left engine (nr 1) flame-out and respective propeller automatically feathered (*picture nr 22*).

Picture Nr 22

Pilot stopped climb at 10500ft, trying to control the aircraft with aileron (*see ruder deflection on opposite direction of expected*), informed the passengers there was an engine failure and they had to jump immediately, while he intended to continue flying the aircraft back for landing at departure airport.

Eleven parachutists jumped in sequence and landed safely on the vicinity of the runway. The other one came to the exit door but reconsidered and returned to the cockpit to accompany the pilot.

<u>NOTE 1</u> – ***With engine failure occurring at high altitude, the pilot had the opportunity to check for the situation, try to restart the failed engine and proceed with normal flight, or make all necessary preparation and perform recommended checklists for a well controlled single engine landing.***

Pilot executed, as usual, a rapid descent and contacted tower on a (high) left base leg for runway 01, without referring any emergency situation or requesting any kind of assistance. He was told to report on final, which he never did.

A few minutes later, the aircraft was seen on final for RWY 01 (*picture nr 23*), at high speed and high descent rate, with gear down and left propeller in feather position.

Picture Nr 23

<u>NOTE 2</u> – ***Aircraft was shown with right wing slightly lowered and some power on operating engine (engine noise was not compatible with idle throttle position). Being the airplane absolutely controllable there's no reason for such overspeed, which hinder the aircraft to touch the runway, while overflying it at all its length (*** *picture nr 24* ***).***

Picture Nr 24

The aircraft made a low pass on all runway length, without touching the ground. Only after it passed the end, now at a lower speed, the pilot decided to reject landing and initiate a go-around.

Engine acceleration was heard and the aircraft started to deviate to the left, now with wings levelled, until becoming out-of-sight (*picture nr 25*).

Picture Nr 25

NOTE 3 – ***With such airplane attitude (wings levelled and maximum power on operating engine) Vmc suffered a small increase, relatively to Aircraft Operating Manual (AFM) referred value (calculated for a 5º bank and maximum continuous power), the pilot was flying the aircraft exercising force on flight controls (all trims were at neutral) and on critical speeds boundary (Vs and Vmc).***

When the aircraft became visible again, a few seconds later, it showed a steep bank position, near inverted flight, close to Almeirim residential quarter.

NOTE 4 – ***This attitude is well illustrative of airplane directional control loss due speed bellow Vmc, with engine asymmetrical thrust forcing the aircraft to enter a spiral dive at low altitude, without a chance to trade altitude for speed.***

A "bang" was heard and lots of flames and a black smoke cloud were seen. The aircraft collided with an apartments' building and caught fire.

2.4 Engine Failure

Unless there's a mechanical failure, a turbine engine only stops running if fuel or oxygen is missing, once it's a continuous operation process.

In this case there was no mechanical failure that could prevent the engine to continue delivering normal power (*see 1.16.2*), in view of which only a lack of fuel or oxygen could be suspected.

Considering that the other engine kept running without problems, atmospheric conditions didn't present any significant phenomenon and engine air intake was not obstructed, only a fuel starvation remains valid assumption.

The apparently erratic fuel loading system and the lack of refuelling registries prevented to evaluate fuel quantity on board and its distribution by tanks.

The fact that left wing was spared by fire, even if its leading edge has been scratched and wing skin punctured, reinforces the absence of fuel in left wing tanks, as there was no fuel spillage and ignition.

Fuel crossfeed valve should be closed, as no fuel was found in fuel pump and fuel control unit, most probably because the pilot didn't know about its function and how and when to operate it.

2.5 Pilot Behaviour

Pilot's wilfulness and skilfulness were not enough to overcome the lack of knowledge, airmanship and training usually required to fly this kind of aircraft, leading to the noncompliance with recommended actions and procedures for dealing with an engine failure.

His inexperience in controlling the aircraft in such a situation and his inability to carry a safe landing with one engine inoperative was the main reason for the accident.

Pilot's persistency in flying a twin, knowing he was not qualified to do it, equals Civil Aviation Authorities disregard for regulation's accomplishment, closing their eyes for this type of aviation operations, without monitoring pilot and aircraft's irregularities, especially with foreign registrations.

3. CONCLUSIONS

3.1 Findings

Based on what has been exposed, we may conclude that:

1st The aircraft belonged to the land propeller multi-engine aircraft's classification, had a French registration and a valid Airworthiness Certificate, issued by French Civil Aviation Authority (DGAC) and complied with approved maintenance programme, up to 29-JUL-2009, after which no registries were found;

2nd The pilot was a Private Aircraft Pilot License holder, issued by United States of America Civil Aviation Authority (FAA), valid for single-engine propeller aircraft's flying, with a total take-off mass of 12500Lbs (5700kgs) or less and USA registration;

3rd The operator was registered on Commercial Registry but had no Air Operator Certificate (or Air Work Operator Certificate) and was not registered with Portuguese Civil Aviation Authority (INAC);

4th No request or permit was found, with INAC, allowing the operator to carry commercial operations with that aircraft, inside Portuguese territory;

5th No fuel loading registries were found, preventing determination of total fuel on board and its distribution by tanks;

6th The aircraft suffered engine nr 1 failure, when climbing through 9500ft, in the vicinity of the aerodrome;

7th All passengers, but one (all of them parachutists) left the aircraft in flight and landed safely, in the aerodrome perimeter;

8th The pilot and one passenger remained on board and intended to perform a single engine landing at same aerodrome;

9th First landing attempt was not succeeded and the pilot opted for a single engine go-around;

10th During the go-around, the pilot was unable to control the airplane and crashed against an apartments' building, 1160m far to the left from runway end;

11th After the impact, a fire deflagrated destroying the aircraft;

12th Pilot and passenger suffered fatal injuries.

3.2 Causes of the Accident

3.2.1 Primary Cause

Primary cause for this accident was pilot inability, as he was not qualified to fly this class of aircraft, to carry a single engine landing or maintain directional control during go-around with one engine inoperative.

3.2.2 Contributory Factors

The following were considered as Contributory factors:

1st The pilot was not qualified to operate multi-engine aircrafts and had no knowledge and training to fly this kind of aircraft;

2nd Unsuitable fuel monitoring and omission on manufacturer recommended procedures accomplishment;

3rd Inadequate flying technique, without consideration to the airplane special flying characteristics;

4th Inadequate supervision, by the competent authorities, on flying activities carried by pilots and aircrafts with foreign licenses and registrations, inside Portuguese territory.

4. SAFETY RECOMMENDATIONS

Considering that the main cause for this accident was the lack of knowledge of the pilot for flying multi-engine aircrafts, especially with one engine inoperative;

Recognizing that it could be avoided if there was an effective control of pilot licenses and aircraft documentation, preventing a pilot to fly without required qualifications;

It is recommended to

National Civil Aviation Authority (INAC):

"To implement suitable measures and procedures that could detect General Aviation irregular pilot and aircraft situations and provide the required corrective actions".
(SR 06/2011)

Lisbon, 14th of July, 2011

The Investigator In Charge,

António A. Alves