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GABINETE DE PREVENÇÃO E INVESTIGAÇÃO DE ACIDENTES COM AERONAVES

FINAL INCIDENT REPORT

PRIVATE
EXTRA 300S

N80LA

Santarém

September the 1st, 2008

GPIAA

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

20.OUT.2011

O Director,

Fernando Ferreira dos Reis

FINAL INCIDENT REPORT Nr. 18/INCID/2008

NOTES

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

Safety investigation is a technical process aiming to accident's prevention and comprises the gathering and analysis of evidences, in order to determine the causes and, when appropriate, to issue safety recommendations

In accordance with Annex 13 to the International Civil Aviation Organisation Convention, Chicago 1944, EU Regulation Nr. 996/2010, from European Parliament and Council, 20th OCT 2010 and article 11th n° 3 of Decree-Law n° 318/99, 11th AUG 1999, the sole purpose of this investigation is to prevent aviation accidents. It is not the purpose of any such investigation process and the associated investigation report to apportion blame or liability.

GPIAA was notified immediately after and an Investigator travelled to the site, starting the investigation. That Investigator In Charge left the Department without closing the process and another Investigator has been appointed as Investigator in Charge, starting the review of all gathered information, which is on the basis of this report.

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

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SYNOPSIS

On September, the 1st, 2008, Extra 300S aircraft, s/n 024, registration N80LA, was positioned at Castelo Branco airfield, in order to participate on an air show over Alcafozes, paying homage to “Our Lady of Loreto”, patroness of aviators, organized by aviation personnel and other related institutions.

By 11:40 UTC¹, the aircraft took-off from Castelo Branco and flew direct to Alcafozes where the pilot performed some aerobatic manoeuvres, after which he headed to Santarém aerodrome.

Before he could reach the aerodrome, the engine started coughing and the aircraft landed, powerless, on a small island, in the left of Tagus river bed, about two nautical miles short of runway.

The pilot suffered no injuries and the aircraft sustained minor damage.

¹ - All timings referred in this report are UTC (Universal Time Coordinated) time. At that date, local time in Portugal mainland was equal to UTC + 1 hour.

1. FACTUAL INFORMATION

1.1 History of the Flight

On the Monday, following the last August weekend or first September one, its use to take place a religious festivity in homage to “Our Lady of Loreto”, patroness of all aviators, in the village of Alcafozes, Idanha-a-Nova. For a long time it became a place for aviation people gathering and some air displays usually take place, honouring Our Lady, while the procession covers the village streets.

That year of 2008, these festivities took place on the 1st of September. There were several aircrafts taking part on the air show, being N80LA one of them. Light aircrafts elected to station at the nearest aerodrome, Castelo Branco, departing from there for the display.

Before departure from Castelo Branco, the aircraft was refuelled by another pilot, who filled up ACRO/CENTRAL tank but added nothing to wing tanks.

The aircraft took-off at 11:40 for a trip of ten minutes time to Alcafozes, where it had to hold for another five minutes, prior to its display of eight minutes, after which it headed to Santarém (*picture nr 1*).



Picture Nr 1

The pilot declared that, on the way to Santarém, he decided to simulate an engine failure approach to an unprepared field and, when passing 500ft, he tried to recover and proceed to destination, but the engine didn't react to power demand. Having a partial engine power loss, the pilot managed to make an emergency landing on a small river island, just the aiming point of his intended simulated engine failure approach.

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After landing, the aircraft slid for 27m, approximately, and rested on its belly, with main gear detached (*picture nr 2*).



Picture Nr 2

1.2 Injuries

There was only one pilot on board, who suffered no injuries.

1.3 Aircraft Damage

The aircraft was slightly damaged, suffering minor damage underneath the fuselage, after the main landing gear dislodged and breaking propeller blades' tips (*picture nr 3*).



Picture Nr 3

1.4 Other Damage

There was no third party damage reported.

1.5 Personnel

On board the aircraft there was only one pilot, with following references (*table nr 1*):

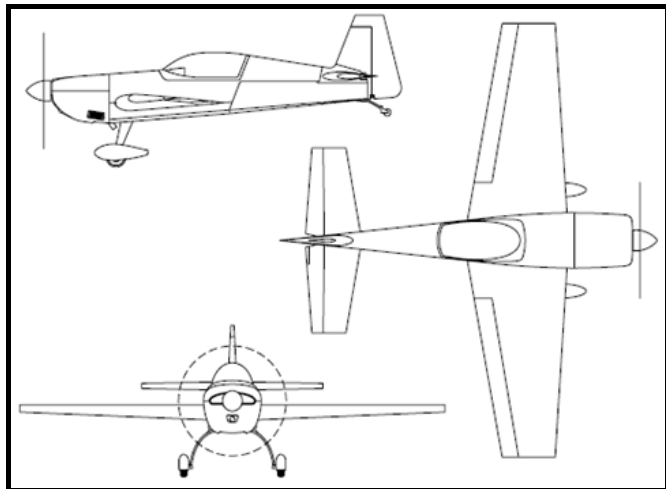
Personal:	Sex:	Male	
	Age:	37	
	Nationality:	Portuguese	
	Flight License:	ATPL(A)	
	Validity:	03-JUN-2013	
	Ratings:	SEP;ME;A-300/310/330	
	Last Medical Examination:	19-JUN-2008	
Flight Experience:		Total	On Type
	Total:	4000	60
	Last 90 days:	180	08
	Last 30 days:	60	08
	Last week:	15	01
	Last 24 hours:	01	01

Table Nr 1

1.6 Aircraft

1.6.1 General

The aircraft EXTRA 300/S (*picture nr 4*) was designed and developed by Extra Flugzeugproduktions, in Federal Republic of Germany and registered in normal and acrobatic categories. It's a light weight, robust, single piston-engined, one seat aircraft with a fuselage structure in TIG welded steel tube construction and landing gear, wing and tail made of epoxy, reinforced with glass and carbon fibre.



Picture Nr 4

Aircraft with registration N80LA, used to be flown by a couple of Portuguese aerobatic pilots and presented the following characteristics (*table nr 2*):

Reference	Airframe	Engine	Propeller
Manufacturer:	Extra Flugzeugbau	Textron Lycoming	MT-Propeller
Model:	EA 300/S	AEIO-540-L1B5	MTV-9-B-C/C200-15
Serial Nr.:	024	L-25373-48A	P-24-NE
Flight Time:	N/A	N/A	N/A
Landings / Cycles:	N/A	N/A	N/A
Last Inspection:	N/A	N/A	N/A

Table Nr 2

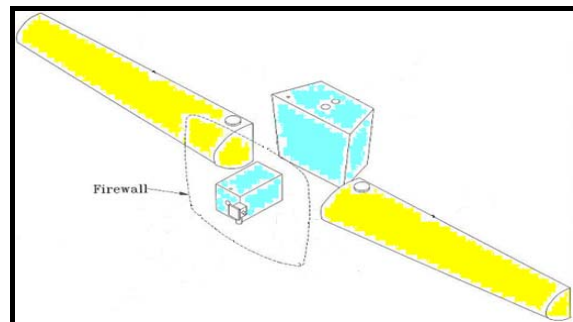
There was no information regarding the aircraft and its components, no flight time registry nor maintenance records. The only documentation regarding the aircraft was a copy of "Certificate of Aircraft Registration" issued to Marco Cardoso Botelho de Melo, dated May 01, 2008, together with a "Standard Airworthiness Certificate" valid for Normal & Acrobatic Category operation, issued on 05/07/2008, by FAA, under designation number DART810262EA. No other documentation was found.

1.6.2 Fuel System

1.6.2.1 Description

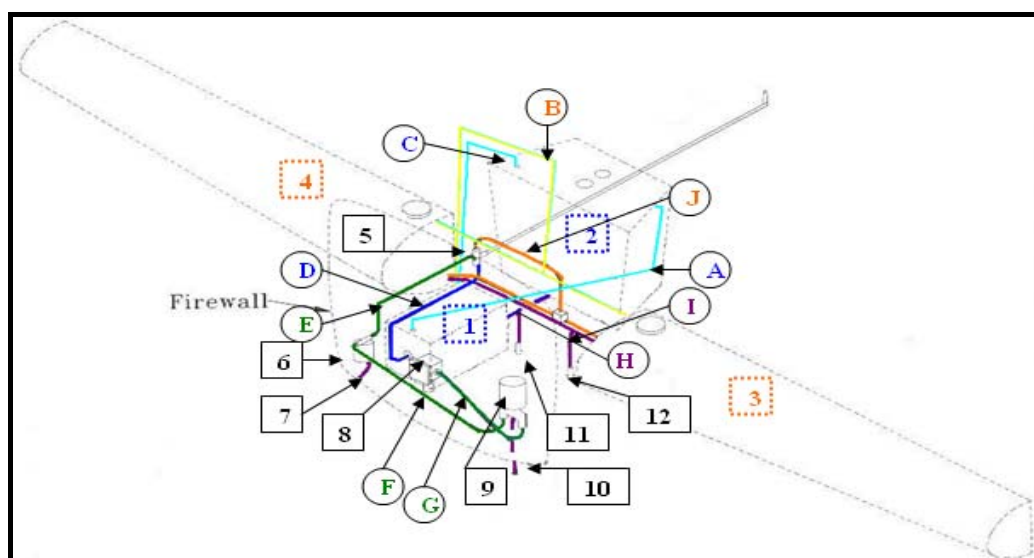
The EXTRA 300S aircraft is equipped with two independent fuel systems (*picture nr 5*):

- a) Acro & Centre tank system (*mounted in the fuselage*);
- b) Wing tanks system (*mounted in the root section of each wing, in front of main spars*).



Picture Nr 5

The 2.3US Gal. capacity Acro tank (1, *picture nr 6*), incorporating an inverted flight fuel supply system, is mounted in the fuselage, just behind the firewall. It is connected to the 11.1US Gal. capacity Centre tank (2), which is mounted behind the main spar area, by a flexible hose (H). Fuelling Acro & Centre tanks is by means of a fuselage filler cap, on top. Acro tank de-aerates into the Centre tank (A), which de-aerates, by a ventilating tube (C) ending outside the fuselage at the right side of main landing gear spring. Draining of Acro & Centre tanks is accomplished by a common drain valve (11) situated under the fuselage, on right hand side, behind main landing gear.



Picture Nr 6

The root section of each wing, in front of main spars, forms an integral fuel tank of approximately 59" (150cm) length (3 & 4, picture nr 6). Each Wing tank, with a capacity of 15.85US Gal., has a filler cap for gravity fuelling and they are interconnected by fuel and ventilation lines. The main ventilation tube (B) ends outside the fuselage, at right side of main landing gear spring. Draining of Wing tanks is accomplished by one common drain valve (12) situated under the fuselage, on left hand side, behind main landing gear.

Fuel from Acro & Centre tank, flowing through fuel line (D) and Wing tanks fuel coming through line (J) reach the three position "Fuel Shut-off & Selector Valve" (5) and is directed, via fuel line (E) through the "Fuel Filter"/"Gascolator" (6) and fuel line (F) to the "Electric Auxiliary Fuel Pump"/"Boost Pump" (9) and, by fuel line (G), to the "Engine Driven Fuel Pump" (8), which feeds the engine. Additional fuel drains are fitted to the fuel filter (7) and, from aircraft MSN 30 onwards, to the electric auxiliary fuel pump (10).

Fuel quantity indication is provided in the cockpit by two indicators (picture nr 7), one connected to a tubular tank unit located in centre tank and another connected to a liver-type tank unit located in left wing tank. Maximum fuel quantity as follows (table nr 3):



Picture Nr 7

Total fuel volume 171 litres (45,1 US Gallon)
- Wingtanks (2 x 60 l) 120 litres (31.7 US Gallon)
- Center tank 42 litres (11,1 US Gallon)
- Acro tank 9 litres (2,3 US Gallon)
Usable fuel in the system 169 litres (44,6 US Gallon)
Usable fuel for acrobatic (acro and center tank) 49 litres (12.9 US Gallon)

Table Nr. 3

1.6.2.2 Servicing & Operation

Before flight, the aircraft should be fuelled with the required amount for the intended flight, having in account that the wing tank must be empty for acrobatic manoeuvres and there's an amount of 0.5US Gal. unusable fuel. Usually Acro & Centre tanks are filled first and then the remaining fuel is stored in Wing tanks. When wing tanks are to be filled up, after fuelling the second tank, the first one should be refuelled, to account for fuel migration during second tank fuelling.

During pre-flight inspection, fuel quantity should be checked by dipstick. All fuel tanks and fuel filter should be drained before flight, to clear residual water and moisture. Booster pump must be "ON" for take-off and landing. It is recommended to set fuel selector to "ACRO & CENTRE TANK" position, prior to start up the engine and when starting descent for landing.

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CHECKLIST HIGHLIGHTS	
- BEFORE START:	
1-Cockpit	
5. Fuel quantity indicators	CHECK
7. Fuel selector *	ACRO & CENTER TANK
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">NOTE *</div> <p>Although safe operation did <u>not</u> require the use of the tanks in a specific sequence, it is recommended to set fuel selector to "ACRO & CENTER TANK" position!</p>	
2-Right Wing	
3. Fuel tank vent opening (right landing gear)	CHECK
4. Fuel quantity	CHECK
5. Fuel tank filler cap	CHECK
3-Nose	
4. Acro & center fuel tank drain	DRAIN FOR AT LEAST 4 SECONDS TO CLEAR SUMP OF POSSIBLE WATER; CHECK CLOSED
5. Wing fuel tank drain	
6. Fuel filter drain	
4-Left Wing	
2. Fuel quantity	CHECK
3. Fuel tank filler cap	CHECK
- CLIMB:	
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Turn boost pump "OFF".</div>	
- CRUISE:	
2. Throttle/RPM	- Adjust for cruising speed
3. Mixture	- Adjust for minimum fuel consumption
5. Fuel	- Check periodically
- DESCENT:	
1. Throttle	- Reduce
2. Mixture	- "FULL RICH"
5. Fuel selector*	- "ACRO & CENTER TANK"
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">NOTE *</div> <p>Although safe operation did <u>not</u> require the use of the tanks in a specific sequence, it is recommended to set fuel selector to "ACRO & CENTER TANK" position!</p>	
- APPROACH:	
1. Boost pump	- ON
2. Mixture	- set to "Rich"

Table Nr 4

1.6.2.3 Warnings

For pilot notification and awareness the following labels should be well visible in cockpit, near or under fuel quantity indicators:

**WING TANK
MUST BE EMPTY FOR ACROBATICS**

**THE REMAINING FUEL IN LEVEL FLIGHT
CANNOT BE USED SAFELY
WHEN INDICATOR READS "ZERO".**

**ACRO & CENTER TANK
SHOWS "ZERO" IN LEVEL FLIGHT BELOW 11.6 L (3 US GAL.)
UNUSABLE FUEL: 2 L (0.5 US GAL.)**

1.6.2.4 Fuel Calculations

Engine fuel consumption varies with engine power settings, altitude and temperature. Aircraft Manufacturer issued Pilot Operating Handbook presents required graphs & tables for fuel calculations. Average fuel consumption, for flight planning, may be considered as:

▶ Warm up & Take-off	1.32 US Gal. (5 litres) – fixed value
▶ Climb (Maximum Continuous Power)	18.2 US Gal./hour (69L/h)
▶ Cruise (65% Power)	13.3 US Gal./hour (50L/h)
▶ Cruise (55% Power)	11.3 US Gal./hour (42,6L/h)
▶ Aerobatics	26.4 US Gal./hour (100L/h)
▶ Inflight Reserves (45 minutes at 45% power)	5.55 US Gal. (21L) – standard value

Having in mind these figures, for the intended flight:

◆ Take-off from Castelo Branco, climb to 5500ft	3 minutes
◆ Fly 16NM to Alcafozes	8 "
◆ Air display over Alcafozes	8 "
◆ Flying 82NM to Santarém	34 "

minimum fuel to be on board at departure should be:

a) Normal Operation:

● Warm up & take-off	1.32G (5L)
● Climb (3')	0.85G (3,3L)
● Cruise (to the display – 5')	1.10G (4,1L)
● Air Display (8')	3.52G (13,32L)
● Cruise (to Santarém – 34')	7.40G (28L)
● Reserves (45')	5.55G (21L)
● Unusable Fuel	0.50G (2L)
Total Fuel Required	20.24G (76,72L)

This would imply that wing tanks had to be fuelled with 6.84Gal (25,72L), which means there would be 3.57Gal (13,32L) on wing tanks at time of acrobatic display starting. To avoid this to happen, it was necessary to put 3.27Gal (12,4L) on wing tanks only. In that case the total amount of fuel at departure would be 16.67Gal (63,4L) and reserve fuel would be reduced to 15 minutes only.

b) Acrobatic Flight (with wing tanks empty for acrobatics):

● Warm up & take-off	1.32G (5L)
● Climb (3')	0.85G (4L)
● Cruise (to the display – 5')	1.10G (3,4L)
● Air Display (8')	3.52G (13,32L)
● Cruise (to Santarém – 34')	7.40G (28L)
● Reserves (15')	1.98G (7,68L)
● Unusable Fuel	0.50G (2L)
Total Fuel Available	16.67G (63,4L)

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1.7 Meteorology

That day the weather was fine in all the entire area flown by the aircraft, under the influence of a high pressure system (1019hPa). The sky was almost clear, with few clouds above 3000ft, visibility of more than 12.5 Miles (20 KM), wind calm (less than 5kts) from north sector, temperature 28°C, dew point 14°C and relative humidity 40%.

1.8 Navigation Aids

Not applicable.

1.9 Communications

The pilot submitted a Flight Plan to ATM provider and established normal communications with radio stations involved with the flight, namely with Flight Information Service (FIS), based at Lisbon and known as Lisbon Military (LISMIL). Only communications with FIS were recorded and so they are the only ones to be recovered for analysis. It was not possible to confirm communications with Castelo Branco and Tancos.

1.10 Landing Site

The landing place was a small sandy island in Tagus river bed, which becomes visible only when the water flow decreases and the river reverts to a small stream of water. Nearest aerodrome was less than 2NM away (Santarém aerodrome) and landing site was close to runway axis, which means pilot was performing a direct approach to RW 23 (picture nr 8).



Picture Nr 8

There were no obstacles along the approach path or on ground, only sparse small weeds, but the soil was not hard enough to sustain aircraft weight on wheels. Along the river margin there were some trees and shrub, typical of that kind of environment (*see picture nr 9*).

1.11 Flight Recorders

The aircraft was not equipped with flight recorders and they were not mandatory for that type of aircraft.

1.12 Wreckage & Impact



Picture Nr 9

The aircraft remained compact, with only small parts separating from main structure (gear fairings and fuse plus ailerons' aerodynamic trim).

The first impact on the ground was with tail wheel, followed by main wheels, about 5m ahead. When main wheels sank in the sandy floor, gear fuse broke and main landing gear separated. Then, aircraft belly set down and slid for approximately ten metres, veering slightly to the right, until aircraft immobilization (*picture nr 9*).

Aircraft's belly suffered some scratches and abrasion. Propeller blades impacted the ground and all had broken tips. The first (top one) showed only a small piece missing, but the other two blades lost about one third of their length (when being dragged along).

Propeller blades damage confirmed the engine was not delivering power at the moment they contacted the ground.

Mixture control lever stop was found broken. Fuel selector valve was selected to “ACRO & CENTRE” tank.

When the Investigator arrived at the scene, there was a gasoline smell in the air, but no petrol was seen, being it absorbed by the sand. When checked for remaining fuel, centre tank was empty and wing tanks seemed to have some residual fuel but indicator was reading zero and dipstick showed no reading.

1.13 Medical &/or Pathological

Not applicable.

1.14 Fire

There was no fire.

1.15 Survival Aspects

Not applicable.

1.16 Tests & Research

1.16.1 Engine

Lycoming AEIO-540-L1B5, s/n L-25373-48A engine was removed from the aircraft and sent to an engine maintenance & repair plant, for testing.

The engine was checked, as per manufacturer recommended procedures, dismantled, cleaned, inspected and reassembled.

Nothing was found that could impair normal behaviour of the engine and normal power delivery, before and after the incident.

1.16.2 Fuel System

Fuel system was inspected for its integrity and tested for possible leaking and for components performance, especially fuel filter and fuel pumps.

When the aircraft was lifted, to be removed from the site, centre tank fuel drain was found detached from main line. No other damage was found, regarding fuel system components. All tanks and fuel lines were clean and there were no leaks.

Fuel filter was clean and without contamination. Electric auxiliary and engine driven fuel pumps were running and delivering normal pressure, as per their original settings.

1.16.3 Fuel Management

The aircraft was refuelled at Castelo Branco, by another pilot, who was giving his support to the event, but there was no recording of refuelling operations, once fuel was provided free by local flying club. According fuelling man declarations, he only refuelled centre tank, letting it full.

There's no aircraft registry of potential fuel amount in wing tanks at that time, but the pilot referred he had 5.28USG (20L) in each wing and full centre tank (13.4USG - 51L), amounting to a total of 24USG (91L), when leaving Castelo Branco to Alcafozes, at 11:40, which means he was 3.76USG (14,28L) above minimum required fuel for the entire flight (1.6.2.4 a)) and 7.33USG (27,6L) above maximum fuel for aerobatic flight (1.6.2.4 b)), once he had to start aerobatics with wing tanks empty, unless there was some change on flight progress that could contribute to burn the excess fuel, before starting aerobatics.

Asking the pilot about flight progress, first appointed Investigator in Charge was informed that *"take-off was at 11:40, the flight took about 10 minutes from Castelo Branco to Alcafozes, having to hold for another 10 minutes before starting aerobatic display. The display took 8 minutes and, afterwards, the pilot flew direct to Santarém, landing on the river bed 37 minutes later (12:45)"*, which makes a total flight time of 01:05. No explanation was given about the reason for those ten minutes time holding, before starting aerobatics.

Applying the same calculation as in 1.6.2.4, **used fuel** on that course should be:

• Warm up & take-off	1.32USG (5L)
• Climb (3')	0.85USG (3,3L)
• Cruise (to the display – 7')	1.54USG (5,8L)
• Hold at Alcafozes (10')	1.98USG (7,78L)
• Air Display (8')	3.52USG (13,32L)
• Cruise (to Santarém – 37')	8.14USG (30,7L)
Total used fuel	17.35USG (65,9L)

Assuming departure from Castelo Branco with a fuel load of 24USG (91L), on arrival there should be 6.65USG (25,1L) remaining in tanks. Using same reasoning, the pilot started aerobatics with 4.9USG (18L) of fuel in wing tanks, against Aircraft Manual recommendation.

1.17 Organizational & Management

Not applicable.

1.18 Additional Information

From Air Traffic Management Services (ATM) it was possible to recover a copy of Flight Plan, radio communications between aircraft & FIS transcriptions and relevant radar snap-

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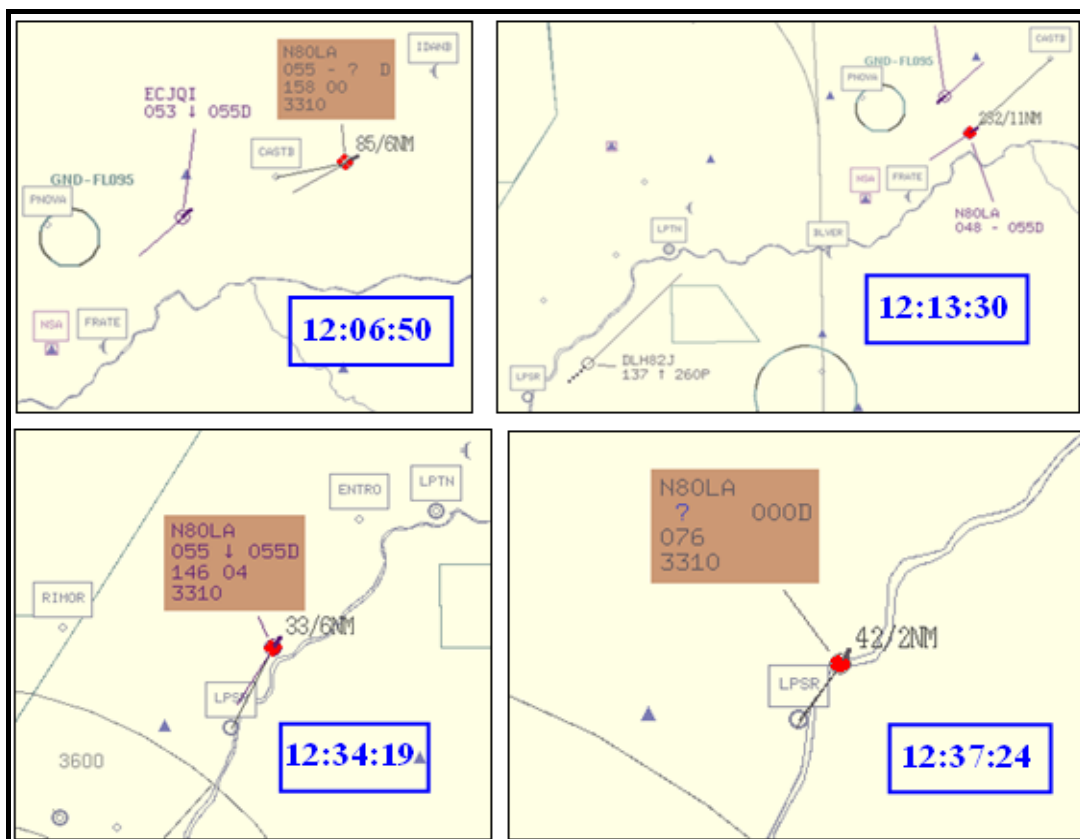
shots, covering the route from aerobatic display site (Alcafozes) to destination aerodrome (Santarém).

According Flight Plan submitted to ATM Services, the flight would depart from Castelo Branco (LPCB), by 11:15, flying to Alcafozes and, from there, directly to Santarém (LPSR), having Ponte de Sôr (LPSO) as alternate and an elapsed time of 45minutes. No endurance was referred.

```
011056 LPPCFZFX (FPL-N80LA-VX  
-E300/L-SV/C  
-LPCB1115  
-N0150VFR ALCAFOZES DCT  
-LPSR0045 ZZZZ  
-ALTN/PONTE DE SOR OPR/ATAA)
```

(copy of Flight Plan)

Looking into radar snapshots (picture nr 10), the aircraft was first identified, on its way from Alcafozes to Santarém, at 5500ft (12:06:50 – first radar positive contact). Later it was spotted at 4800ft (12:13:30 – when pilot declared his intention to contact Tancos Tower in order to confirm if there was traffic in its reserved area, which was activated by NOTAM), again at 5500ft (12:34:19 – when, starting descent, it was transferred to Santarém for local traffic information) and finally, without receiving mode “C” (12:37:24 – last radar contact, 2NM North-east of Santarém aerodrome and 76kts speed).



Picture Nr 10

1.19 Special Investigation Techniques

No special investigation techniques were used.

2. ANALYSIS

2.1 Flight Preparation

No special preparation was done for the flight. The aircraft used to be flown by two pilots and no coordination between them was reported. The only coordination was with Castelo Branco Flying Club President, responsible for the air display organization and provision for aircraft fuelling and assistance at the aerodrome. He was, supposedly, the responsible person for issuing and coordinating the timings for aircraft's presentation.

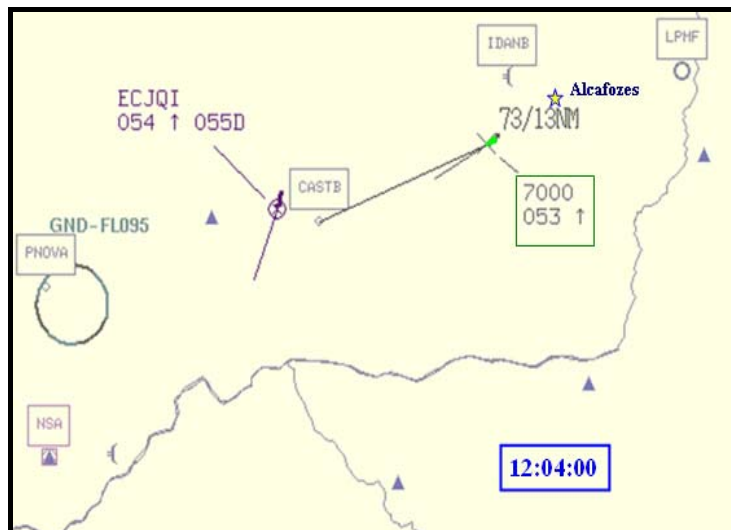
2.2 Flight Progress

Taking-off at 11:40, the pilot estimated to be overhead at 11:50, on time for his performance.

It was never clarified why N80LA had to hold for about five more minutes, prior to commence his aerobatic display, which the pilot really did, starting his performance at 11:55 and taking approximately eight minutes.

Once terminated his display (12:03), the pilot headed to Santarém, flying at an average altitude of 5000ft and contacted, for the first time, Flight Information Service (FIS).

On first contact with FIS (12:04:00), the aircraft had not received transponder code yet and could not be positively identified. Even so, radar registered an aircraft (*picture nr 11*), which corresponded to N80LA position information (*flying away from Alcafozes and heading to Santarém, maintaining an altitude of 5300ft and climbing to requested 5500ft altitude*).



Picture Nr 11

Analysing this and the other duly certified radar snapshots (*picture nr 10*), associated with radio communications registered with Flight Information Services, flight profile seems to have been the one described below.

Once acrobatic display was terminated, pilot established on course to Santarém and called FIS (12:04:00), being assigned transponder code 3310, which allowed radar operator to positively identify the aircraft at 12:06:50, 10NM away from Alcafozes (6NM to Castelo Branco), flying at an altitude of 5500ft and 158kts ground speed.

At 12:13:32 pilot requested information about traffic in Tancos reserved area (*parachute jumping*), which was activated by NOTAM, in order to proceed through it directly to Santarém. FIS controller informed he had no such information but the area was active and N80LA should avoid it, just in case.

The pilot should be uneasy with situation and anxious to contact Tancos himself. So, at 12:20:36 informed FIS controller that he was leaving his frequency to contact Tancos Tower, being cleared to do so (on frequency 122.10MHz) and coming back to FIS frequency at 12:21:40.

By 12:34:19 pilot called again FIS, but transmitted no message because the controller anticipated position information and declared "*...he should be with Santarém in sight, he could start descent and contact Santarém for local traffic information*". Being, that moment, 6NM far from Santarém (5500ft and 146kts) and becoming grounded at 1.75NM, it's supposed that aircraft engine was out, by the time, and this distance corresponds to aircraft gliding path.

The flight was identified, by the last time (12:37:24), 2NM Northeast of aerodrome, maintaining 76kts (*recommended engine out speed = 80kts*) without receiving mode "C" (altitude information).

2.3 Fuel Management

Once the tests and examination of the engine concluded there was no defect that could impaired the engine to perform normally, before and after the incident, the only reason to be considered for the engine failure seems to be fuel starvation.

Fuel system was found in good condition, fuel filter was clean and fuel pumps were operating normally, so only a lack of fuel could justify engine problems. Fuel tanks were found empty and the fact that acro/central tank drain valve was found detached, means that unusable fuel (0.5USG) was lost through drain line, leaving a recognizable gasoline smell but leaving no fuel stain in the soil.

Pilot declaration saying he left Castelo Branco with full acro/centre tank and 5.3USG (20L) in each wing tank, can not be accepted, considering it was unjustifiable for an experienced acrobatic pilot, knowing aircraft limitations, to disregard Aircraft Manual restriction ***to perform aerobatic manoeuvres only with wing tanks empty***, specially when there was a so great amount of fuel for it to be not noticed (*see 1.6.2.4 b*)).

So, it is more consistent the assumption that the aircraft left Castelo Branco with acro/centre tank full, as per refueller's declaration, or with a minimum amount of remaining fuel in wing tanks, as may be concluded from gathered evidence.

Fitting flight times with information retrieved from communications and radar snapshots, it's possible to build the puzzle (*table nr 5*).

Flight Phase	Fuel (Gallons / Litres)	
	Used	Remaining
❖ Before departure from LPCB	-----	13.40USG (51,00L)
❖ Warm up & take-off	1.32USG (05,00L)	12.08USG (46,00L)
❖ Climb (3')	0.85USG (03,30L)	11.23USG (42,70L)
❖ Cruise (to the display – 7')	1.54USG (05,80L)	09.69USG (36,90L)
❖ Hold at Alcafozes (5')	0.62USG (02,33L)	09.07USG (34,57L)
❖ Air Display (8')	3.52USG (13,32L)	05.55USG (21,25L)

Table Nr 5

This **estimated** quantity of fuel remaining once aerobatic display terminated, deducted 0.50USG (2L) of unusable fuel, would be enough to fly for 23 minutes, at a 65% power regime (2200RPM) and 163kts speed (TAS), or for 27 minutes, at a 55% power regime (2000RPM) and 154kts speed, which would covered a distance of 63NM or 70NM, respectively.

Considering that the pilot noticed fuel shortage (*which comes up from communication's substance between pilot and FIS controller and the flight track followed*), he selected the most suitable regime of 55% power and the distance from Alcafozes to Santarém was 82NM, when fuel expired there would be a 12NM distance to cover and it would be reasonable to accept that the engine was out at 12:34, 6NM northeast of the aerodrome, being the aircraft on a speed reducing phase (146kts) for the gliding speed (80kts).

3 CONCLUSIONS

3.1 Findings

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

- 1st The flight has been programmed but no preparation actions came to our knowledge;
- 2nd The pilot was qualified for this type of flight and he was familiar with the aircraft;
- 3rd Aircraft Airworthiness Certificate, issued by FAA, was within its validity period, but there was not a registry of inspections or other maintenance actions performed;
- 4th The aircraft was refuelled before the flight, being Acro & Centre Tank full (13.4USGal. – 51L), but there was no information about fuel quantity in Wing Tanks;
- 5th Before reaching destination aerodrome, the aircraft suffered an engine failure and the pilot landed 1.75NM (3,250km) short of runway;
- 6th Engine inspection revealed no deficiency or abnormality that could justify the engine not to deliver regulated power;
- 7th Fuel system showed no leaks and all components tested had a normal behaviour and performed as expected;
- 8th Aircraft fuel tanks were found empty;
- 9th Acro/Centre tank drain valve was disconnected during aircraft sliding on ground, there was a gasoline smell but there was no fuel stain on ground;
- 10th The aircraft suffered minor damage;
- 11th The pilot suffered no injuries.

3.2 Causes of the Accident

3.2.1 Primary Cause

Primary cause for the emergency landing was engine failure, probably due to fuel starvation.

3.2.2 Contributory Factors

The following were considered as Contributory factors:

- 1st The fact that the pilot had to hold for five minutes, prior to start his aerobatic performance, burning more fuel than expected;
- 2nd Pilot fuel miscalculation and management, without minimum reserve fuel for the course to be flown or for other contingencies and for not making use of available aerodromes, enroute, for emergency landing and/or refuelling.



4 SAFETY RECOMMENDATIONS

At this moment it is no more adequate to issue any safety recommendation.

Lisbon, 19th of October 2011

The Investigator In Charge,



António A. Alves