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Report IN-011/2019

Incident involving a Tecnam P2006T aircraft, registration EC-LHB, in Torre de Claramunt (Barcelona) on 1 March 2019

GOBIERNO DE ESPAÑA

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NOTICE

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

Contents

Abbreviations

ACC	Area control center
AESA	Spain's National Aviation Safety Agency
AIP	Aeronautical information publication
ATC	Air traffic control
ATPL (A)	Airline transport pilot license (airplane)
cm	Centimeter(s)
CPL (A)	Commercial pilot license (airplane)
FL	Flight level
ft	Feet
h	Hours
IFR	Instrument flight rules
km	Kilometers
kt	Knots
l	Liters
m	Meters
min	Minutes
sec	Seconds
S/N	Serial number
UTC	Coordinated universal time
VFR	Visual flight rules

Sinopsis

Owner and operator:	Aeroclub Barcelona Sabadell
Aircraft:	Tecnam P2006T, registration EC-LHB
Date and time of incident:	Friday, 1 March 2019 at 16:28 local time[1]
Site of incident:	Torre de Claramunt (Barcelona)
Persons on board:	Crew: 2 (uninjured)
Type of flight:	General aviation – flight training – dual control
Flight rules:	VFR
Phase of flight:	En route – normal descent
Date of approval:	29 May 2019

Summary of the incident:

On Friday, 1 March 2019, a twin-engine Tecnam P2006T, registration EC-LHB, belonging to the Aeroclub Barcelona-Sabadell, made an emergency landing on a crop field 6 km south of the aerodrome of Igualada after both engines stopped in flight.

The flight had started at the Sabadell Airport, with the crew then flying to the Pamplona Airport, where they performed a fly-by, and it was on the way back to Sabadell when the emergency took place. It is estimated that the landing was made at approximately 16:28:50, after 3 h 21 min of flight time. Neither individual on board, the instructor and a student, was injured and the aircraft was not damaged.

The investigation has concluded that the engines stopped due to the failure to adhere to the refueling procedures in the Flight Manual, which caused both engines to stop mid-flight due to fuel starvation. It is estimated that the aircraft took off with the tanks at 75% of their total capacity.

This report does not contain any safety recommendations.

[1] All times in this report are local. To obtain UTC at the time of year when the event occurred, subtract 1 hour from local time.

1. FACTUAL INFORMATION

1.1. History of the flight

On Friday, 1 March 2019, a twin-engine Tecnam P2006T aircraft owned by the Barcelona-Sabadell flight club took off from the aerodrome of Sabadell at 13:07 with two persons on board, an instructor and a student. It was a dual-control training flight that was part of an airline transport pilot license ATPL(A) course.

After a last-minute change in plan[2], the flight was started with the following plan: an away leg to the Pamplona Airport at FL90, a fly-by of the airport without landing and a return leg to Sabadell at FL1000. The entire flight would be conducted under IFR with the exception of the arrival at Sabadell, which would be done in VFR after requesting a change in flight rules from ATC.

The aircraft reached Pamplona and began the return flight at 15:04. At 16:18, in contact with the Barcelona ACC, the aircraft requested to change from IFR to VFR and, 10 min later, at 16:28:01, the crew declared a MAYDAY due to an engine failure. The aircraft had sustained a dual engine failure, first involving the left engine, which failed again after they managed to re-start it, and then the right engine.

The landing took place in a crop field without further incident. Neither occupant was injured and the aircraft was not damaged.

Figure 1. Condition of the aircraft after the emergency landing

[2] As the two occupants stated, the flight was initially going to involve the instructor and two students, one of whom would fly the aircraft to Pamplona, where they would land and then change positions, with the second student flying on the return leg. Since the second student forgot his documentation, his presence on board was canceled. As a result, the flight plan filed listed three individuals on board and a landing in Pamplona, which was eventually replaced with a fly-by.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
Minor				
None	2			
TOTAL	2			

1.3. Damage to aircraft

None.

1.4. Other damage

None.

1.5. Personnel information

At the time of the incident, the instructor, a Spanish national, was 40 years old. He had a commercial pilot license CPL(A) issued by AESA (National Aviation Safety Agency) with flight instructor rating that was valid until January 2020. He had a total of 3000 flight hours, and 120 hours on the aircraft type. He had a medical certificate that was valid until January 2020. He had been working for the flight club for three and a half years. On the day of the incident, he had gone on a flight earlier on a Piper PA23 twin-engine aircraft that lasted 1:52 h, and which had finished one hour before the start of the second flight. He had flown on the three days prior to the incident.

The student pilot was 26 and had been born in Netherlands. He was taking an ATPL(A) course. He had a medical certificate that was valid until January 2020. He had 132 flight hours, of which 3:06 h had been on the type. The incident flight was his third flight on a twin-engine aircraft. The first had been a week earlier, and the second the day before.

1.6. Aircraft information

The Tecnam P2006T, S/N 024, had been registered in Spain in 2010, the same year it was built. It was outfitted with two Rotax 912S3 engines, with S/N 9563784 (engine 1) and S/N 9564795 (engine 2). At the time of the incident, the aircraft had 2016 flight hours, and the engines 700 and 135 hours (engines 1 and 2, respectively).

The most recent maintenance checks had been as follows:

- 200-h check on 8 February 2019 with 1981 h on the aircraft (3 weeks earlier).
- 25-h check on 26 February 2019 with 2005 h on the aircraft (3 days earlier).

Fuel:

The aircraft can hold 200 l of fuel (between the two wing tanks, with a 100-l capacity each), of which 194.4 l is usable. The amount of fuel is shown on two analog gauges (one for each tank) located in the right panel in the cockpit. Each gauge has marks for 0-30-50-65-100 l.

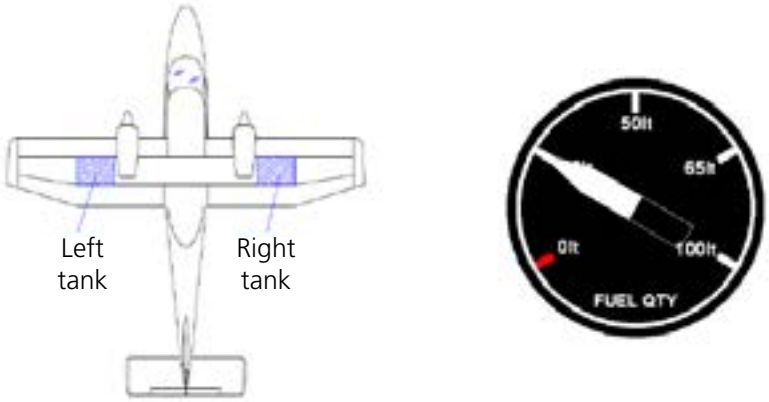

Figure 2. Fuel tanks and gauge in the cockpit

Fuel consumption:

The Flight Manual states that each engine consumes 17 l/h (34 l/h for both engines) of fuel. This is an average value that is defined for certain flying conditions (such as cruise flight at 12,000 ft). For other flight profiles (for example, flying at lower altitudes), the Flight Manual states that consumption can be as high as 28 l/h per engine (56 l/h for both engines).

Excerpts of procedures from the Flight Manual:

The following excerpts from the Flight Manual are relevant to the investigation:

- Pre-flight procedure:

  "3.2. PRE-FLIGHT CHECK - AIRCRAFT WALK-AROUND

  7 Left fuel tank: Check that the refuelling port cap is properly secured, then perform the fuel tank sump drainage ***(…)***

26 Right fuel tank: Check that the refuelling port cap is properly secured, then perform the fuel tank sump drainage (…)"

3.3. COCKPIT INSPECTIONS
12 Fuel quantity CHECK"

- Procedure for landing without engine power:

"10. LANDING EMERGENCIES

10.1 LANDING WITHOUT ENGINE POWER

CAUTION: In case of double engine failure both propellers should be feathered to achieve maximum efficiency. Best glide speed is attained with flap UP (…) Flap can be set to T/O or LAND when landing is assured on final (…)"

1.7. Meteorological information

Weather conditions were acceptable for visual flight.

1.8. Aids to navigation

Much of the flight (the IFR phase) was carried out in controlled airspace, meaning the radar track and the communications with the stations involved (Madrid ACC and Barcelona ACC) were recorded. The information on the flight path and the communications is contained in Section 1.9 so as to provide a more comprehensive account of the flight.

1.9. Communications

At 15:58:32, the aircraft was flying level at FL100 and 150 kt[3], returning from Pamplona, when it first contacted the Barcelona ACC. This communication was made by the student.

At 16:18:38, the student requested to cancel the IFR plan and to descend to a VFR level. They were initially cleared to 6,000 ft and to descend visually later at the discretion of the pilot. They were approximately 50 km west of the Sabadell Airport and, in keeping with the instructions received, the pilot started a descent from FL100. Figure 3 shows the final 8 min of the flight.

[3] Ground speed.

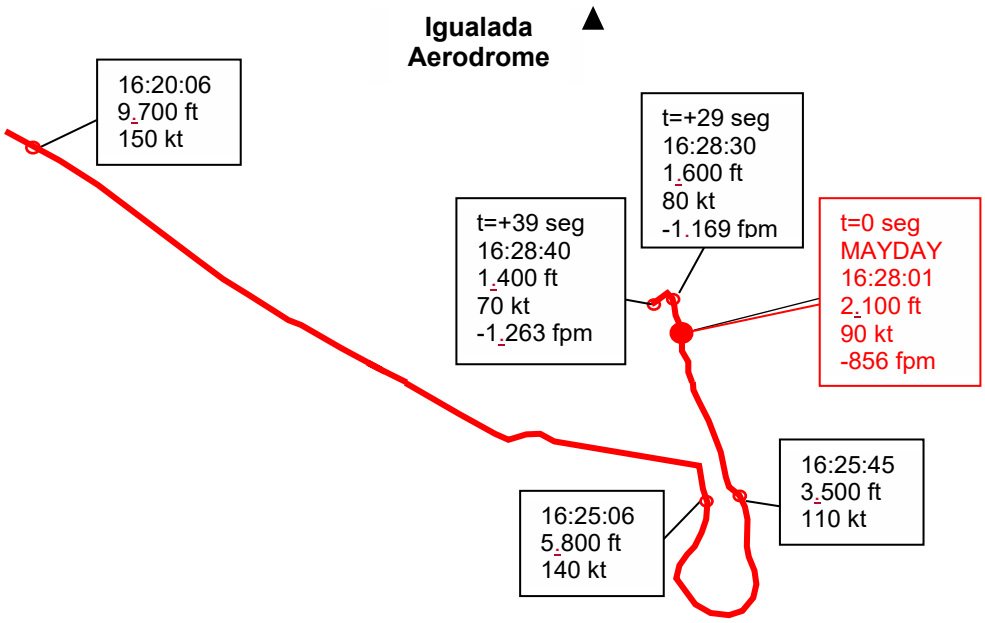

Figure 3. Radar track for the final 8 min of the flight (16:20 to 16:28)

Between 16:20:06 and 16:25:06, the aircraft descended to 5,800 ft:

- at the same previous heading to the southeast
- at the same previous speed of 150 kt
- average vertical speed of -800 fpm

Between 16:25:06 and 16:25:45, the aircraft descended to 3,500 ft:

- it turned to heading north
- it lowered its speed to 110 kt
- average vertical speed of -1,400 fpm

Between 16:25:45 and 16:28:01, the aircraft descended to 2,100 ft:

- it continued flying north
- it lowered its speed slightly to 90-100 kt
- average vertical speed of -1,120 fpm

At 16:28:01 (t=0 sec), the instructor declared a MAYDAY. The aircraft was descending to 2,100 ft, 90 kt at -856 fpm. The subsequent communications were as follows:

t= 0 sec	***"MAYDAY MAYDAY MAYDAY EC-LHB LHB LHB".***
t= +7 sec	The instructor reported their intentions: *"engine failure… Igualada".*
t= +12 sec	The controller acknowledged the information: "*Copied. Engine failure and proceeding to Igualada".*
t= +18 sec	***"We will not arrive. We will land in a field. Full flap, full flap!!".***

There were no more communications with the aircraft.

From the emergency declaration until 16:28:30 (t=+29 sec), the aircraft continued flying north and descending. The last return on a northerly course had it at 1,600 ft, 80 kt and -1,169 fpm.

The next two returns (until 16:28:40) indicated that the aircraft had turned to the southwest, increased its descent rate and lowered its altitude and speed. The last valid data[4] had it at 1,400 ft, 70 kt and -1,263 fpm.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

Not applicable.

1.12. Wreckage and impact information

The aircraft landed in a 240x70 m crop field at an elevation of 363 m (1,190 ft). It was:

- 1 km southeast of the town of Torre de Claramunt (Barcelona)
- 6 km south of the Igualada aerodrome
- 800 m north of the emergency declaration point

[4] The system extrapolated several returns after the last valid position until the radar track disappeared from the system at 16:28:55. These extrapolated returns were not considered or shown in Figure 3.

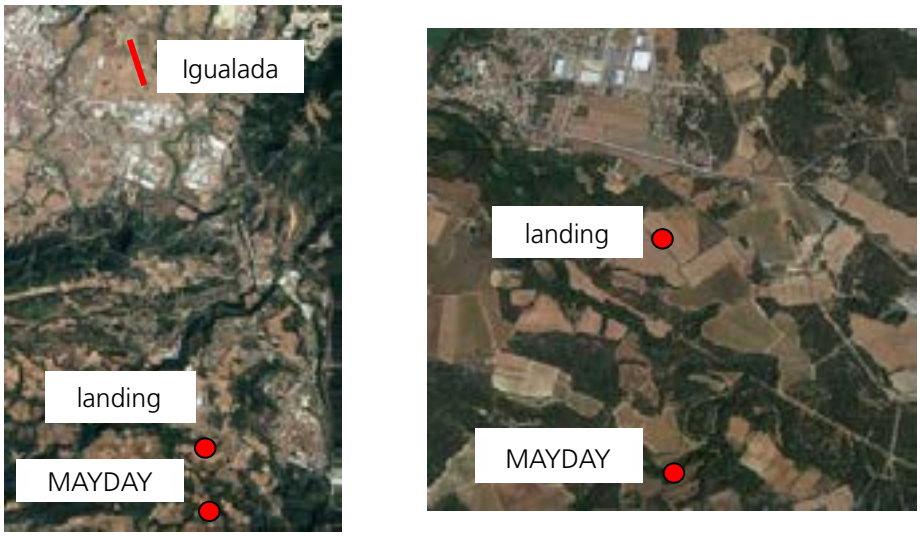

Figure 4. Location of the landing site

1.13. Medical and pathological information

Neither of the aircraft's occupants required medical attention.

1.14. Fire

There was no fire in the aircraft.

1.15. Survival aspects

Since the landing was uneventful, no survival aspects involving the aircraft arose that were considered by the investigation (cockpit structure, seatbelts, etc.).

The aircraft was located thanks to the efforts of air traffic control services:

- At 16:31 (+3 min), and considering that the crew had reported their intention to proceed to Igualada, the supervisor of the Barcelona ACC contacted said aerodrome to inform it of the emergency situation reported by the aircraft, in case its crew made contact.
- At 16:40 (+12 min), there was a series of communications between the controller and another aircraft flying in the vicinity in which the controller reported they had lost radar contact with aircraft EC-LHB, provided its last known radar position and requested information if they saw anything. By chance, the aircraft belonged to the same flight club and was being flown by a friend of the student on board EC-LHB. As a result, the two crews (by way of the students) made contact via mobile telephone, which yielded the first news on the event.

- At 16:41 (+13 min), the other crew confirmed to ATC that EC-LHB had landed on a field. They proceeded to the last known radar position, receiving along the way the coordinates of its location from the crew of EC-LHB.
- At 16:45 (+17 min), the other crew confirmed to ATC that they had the aircraft in sight, and minutes later they provided the coordinates of EC-LHB.
- At 16:48 (+20 min), the coordinates were relayed by the Barcelona ACC to emergency services (112) as part of Enaire's "Emergency reporting procedure".

1.16. Tests and research

1.16.1. Statement from the instructor

The airplane was fully refueled before the flight. Between engine start and takeoff, 20-25 minutes elapsed. During the flight, the fuel tank readings fluctuated:

- Before takeoff, the left fuel gauge read 65 l and the right one 100 l.
- On the away leg, after flying for 1 h 30 min, the right fuel gauge read 50 l and the left one 40 l.
- On the return flight, after 3 h 15 min, near Cervera, the left fuel gauge read almost 0 and the right one between 15 and 30 l.

Since they had left with the fuel tanks full and they had only been flying for 3 h 15 min, he thought the fuel readings were erroneous. The wind was not significant, approximately 15 kt of headwind.

Subsequently, both engines began to fail, first the left and then the right. After the left engine stopped, they did the re-start procedure, which was satisfactory, though only for a short time, since it stopped again. The right engine then stopped. Given this situation, the instructor decided to proceed to Igualada, but they finally opted to land in a field.

He took control of the aircraft during the emergency.

1.16.2. Statement from the student pilot

They refueled before starting the flight (it was the aircraft's second flight that day). He climbed a ladder and visually verified that both tanks were full. He was in the LH seat and the instructor in the RH seat.

On takeoff he noticed that the readings fluctuated. The instructor said that he would monitor the fuel consumption. The left tank seemed to be reading incorrectly on takeoff.

During the flight he handled the communications and flight duties, so he was quite busy. They reached Pamplona, lowered the gear and did a fly-by. They began the return flight. They were at FL100 and descended to 6,000 ft. Once there, ATC told them they could descend to a VFR altitude, about 4,000 ft. The engine stopped as they were descending from 6,000 ft.

The left engine stopped, and with it, his display stopped working. They re-started it but it quickly stopped again. The instructor handled the communications from then on. They decided to go to Igualada, until the second engine stopped as well. He thought the right engine stopped within 2 min of the left engine stopping. They did not try to re-start the right engine. They were at about 3,000 ft when both engines went out.

The descent was much faster than expected. They lowered the flaps and gear. The instructor made a very smooth landing.

After landing he checked the amount of fuel and verified that there was very little fuel left.

1.16.3. Inspection of the aircraft

The aircraft was transported by helicopter to the Igualada aerodrome. There, it was inspected by a team of mechanics from the maintenance center. They checked the operation of the fuel and electrical systems and of both engines, which was satisfactory. The check included the indicator system, which was found to have no defects.

The aircraft was then returned to service. As of the writing of this report, no incidents involving the fuel system (including the indicator system) have occurred.

1.16.4. Refueling test conducted by the Aeroclub

The day after it was taken to the base, the flight club conducted a refueling test to verify the proper operation of the fuel indication systems. This test was carried out by the safety manager and the training manager at the flight club. The aircraft was fully refueled. The fuel logs recorded that 88 l had been supplied, equivalent to filling the tanks to their maximum capacity.

After some time, the amount of fuel in the tanks was again checked, and it was discovered that the aircraft was not fully refueled. The aircraft was again refueled, this time with an additional 14 l of fuel.

The flight club stated that there were two reasons for this:

- The incline angle of the apron, and
- The internal arrangement of the tanks into three compartments that, due to the flow rate in the hose, did not allow the fuel to be transferred from one cell to the next as quickly as the fuel was pumped in.

1.16.5. Calculation of aircraft's average fuel consumption

The aircraft's average overall fuel consumption was calculated using the flight times, not including taxi times, and the refuelings made after 17 February 2019 when the aircraft was fully refueled, until the completion of the incident flight, when there was no fuel in the aircraft. These data yielded an average fuel consumption of 35.3 l/h.

The average fuel consumption after the incident, meaning from the day when the tanks were filled to their maximum capacity during the test carried out by the flight club until 12 March, was also calculated. This resulted in an average value of 35.3 l/h.

1.16.6. Estimate of fuel during incident flight

The flight and refueling logs for the three months before the incident was reviewed. The amount of fuel remaining in the aircraft during the flights was calculated using the flight time and refueling data.

The start date for the calculations was 17 February, which is when the aircraft was last fully refueled. From then on, the average consumption values of 34 l/h (theoretical as per the Flight Manual) and 35.3 l/h (average consumption of EC-LHB) yield the following results:

	Average consumption as per Flight Manual 34 l/h	Average consumption of aircraft EC-LHB 35.3 l/h
Fuel before incident flight started	153.5 l	126.5 l
Fuel when both engines stopped	31.2 l	0 l

1.16.7. Estimate of fuel prior to flight from flight log entries

The logs from flights prior to the incident reveal the following sequence:

- On the previous day (after the last flight made by the same incident crew), the aircraft had 85 l in its tanks.
- On the day of the incident, 85 l was added at 9:22, meaning the aircraft had 170 l (85 from previous day + 85 l added):
  - The flight log entry read Full.
  - The flight began at 10:00 and lasted 1 h 59 min.
  - The fuel used was not logged. Assuming a standard consumption of 34 l/h, the fuel consumed during the flight can be estimated at 67.4 l.
  - After the flight, there should have been 170-67.4=102.5 l of fuel remaining in the aircraft.

- The flight ended at 12:13 and two minutes later (12:15), 50 l was added, giving a total of 152.5 l of fuel in the aircraft.
- The incident flight started at 12:50 (off-block time). The log indicated the aircraft was fully fueled (when, based on the previous log entries, it would have had 152.5 l).

A review of the entries made in the flight log involving refueling, consumption and fuel remaining yielded the following results:

- From 26 February until 1 March, two of the seven entries indicating the aircraft was fully refueled were correct. In the remaining entries, the amount of fuel in the aircraft was below 200 l (174, 184, 172, 170 and 153 l)[5].

1.17. Organizational and management information

The Barcelona-Sabadell flight club conducted an internal investigation and took measures as a result of the incident. These included:

- Reducing the flight time of the flight club's Tecnam P2006T aircraft from 5 h to 3 h 30 min for flights requiring maneuvers and landings and takeoffs.
- Reducing the flight time of the flight club's Tecnam P2006T aircraft from 5 h to 4 h for cross-country flights.
- Visually verifying the amount of fuel in the aircraft after refueling.
- Constantly monitoring the fuel gauges, assuming they are reading correctly.

1.18. Additional information

1.18.1. Procedure for refueling AVGAS fuel

The supplier of fuel at the Sabadell Airport, SLCA, was contacted to obtain information on the refueling process. It confirmed that:

- Every refueling of aircraft EC-LHB between January 2019 and the incident (and afterward) was made from the same refueling unit (identified as FP4220).
- The refueling truck is driven to the location where the aircraft is parked.
- SLCA's personnel at Sabadell confirmed that every refueling request involving the flight club's aircraft is for a full refueling.

[5] This means that the amounts of fuel in the aircraft were between 75%, 85% and 92%.

- The maximum flow rate supplied by the refueling truck is 110 l/min (1.83 l/sec[6]). This maximum flow rate is supplied at the nozzle outlet. This fixed flow rate is obtained when the handle on the fuel nozzle is fully depressed. When partially depressed, the flow rate is lower. In fact, this lower flow rate is used when the tank is nearly full to avoid spills. A flow rate other than the maximum cannot be set.
- The tank is determined to be full visually when refueling.
- The time recorded in the logs is the total refueling time and includes the refueling time for one wing, the switch to the other wing and its refueling time. As a result, it was not possible to determine the time spent refueling each wing tank.
- All refueling was done at apron R-2 at the airport, but they were not confirmed through geolocation.

1.18.2. Effect of flow rate and tank design on refueling

The fuel tanks (outlined in brown in Figure 5) are built into the aircraft's wings. Tecnam was asked for information on the internal structure of the tanks (Figure 5). There are two internal ribs (shown in pink) that divide the tank into three compartments (labeled here 1, 2 and 3 for reference). The fuel is pumped into compartment 1 through the fuel filler at a flow rate (deemed constant) of 1.83 l/sec. To allow fuel to flow from one compartment to another, there are six holes at the bottom of each rib. These are shown in Figure 5 right. For calculation purposes, each hole is assumed to be circular, with a radius of 1.1 cm.

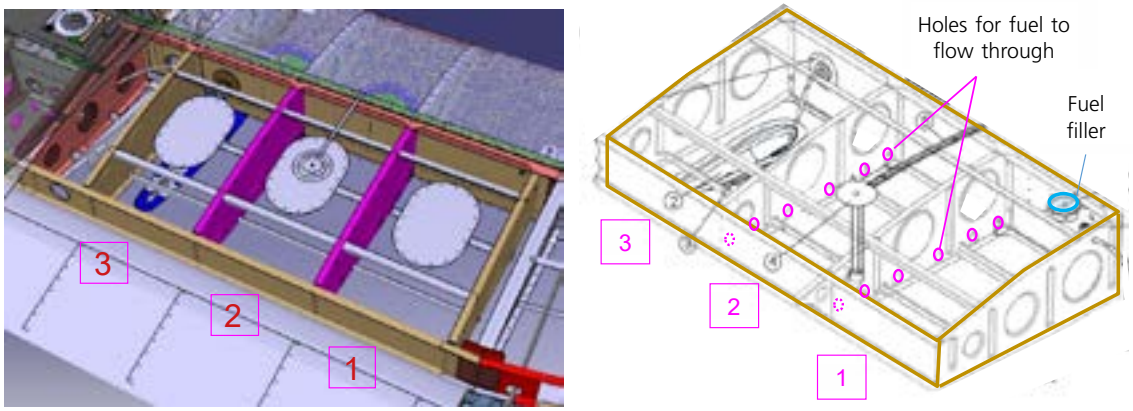

Figure 5. Inside of the fuel tanks (right tank shown)

In order to determine if the six orifices restrict the fuel flow when the three compartments are filled, calculations were done involving the process of refueling the three compartments in series. The results of these calculations show that the compartments are filled simultaneously and that the orifices do not impose any restrictions on the refueling process.

[6] Information included in the AIP (aeronautical information publication): supply from truck at 2 l/sec

1.18.3. Gradient of parking stand 209

The parking stand where the aircraft was refueled before takeoff was number 209. At this stand, the aircraft is facing southwest (approximately 220º), according to information in the AIP.

Based on information provided by the Sabadell Airport (maps showing the inclination of the aprons), and considering the gear-down arrangement of this aircraft and assuming that the aircraft was properly parked during the refueling, the calculations show that the aircraft was leaning 2%to the left, meaning that with the aircraft parked in the expected position, the right wing is higher than the left[7].

Figure 6. Parking stand 209

1.18.4. Effect of the stand angle on refueling

The effect of a 2% aircraft lean angle on filling the tanks was calculated based on the dimensions of the tanks[8]This calculation took into account the fact that the fuel filler is 14.5 cm from the edge of the tank (Figure 5).

The calculation shows that the tanks would be short the following amounts after refueling:

- Right tank: 0.00069 l, meaning it can be completely refueled.
- Left tank: 4.427 l, meaning 95.6 l (out of a total of 100 l) could be supplied.

The maps for apron R2, where the flight club's aircraft are normally refueled, show an incline in excess of 2.5%. The calculations for an incline between 2.5% and 5% show that the tanks would be short about 6 and 12 l (in the tank at a lower elevation).

[7] Nose gear elevation: 139.5 m.
Right gear elevation: 139.52 m.
Left gear elevation: 139.48 m.

[8] Tecnam provided the exact dimensions of each fuel tank: length 1.035 m, width 0.559 m, variable height between 0.217 m and 0.130 m. The calculation assumed a parallelepiped with a constant height of 0.172 m.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

On Friday, 1 March 2019, a twin-engine Tecnam P2006T, registration EC-LHB, made an emergency landing during a dual-control training flight due to the loss of both engines after flying for 3 h 21 min.

The investigation considered the following aspects:

- 2.1: The problem that caused both engines to stop.
- 2.2: The handling of the emergency after the dual engine stoppage.

2.1. Cause of the engine stoppage

The stoppage of both engines was the result of fuel starvation. The check made by the crew after the landing confirmed that this had been the cause of the emergency. Based on the crew's statement that they had started the flight with the tanks full, the aircraft either started the flight:

- with sufficient fuel, followed by a problem during the flight, or
- with insufficient fuel, despite the crew thinking that the tanks were full.

2.1.1. Possibility 1: flight started with sufficient fuel

The photos taken after the incident did not show signs of a fuel leak during the flight that could have reduced the amount of fuel remaining. In this regard, the inspection of the aircraft after the incident did not reveal any problems or breaks in the fuel system. As such, as the visual inspection indicated, the loss of fuel during the flight can be ruled out.

There were also no problems identified with the operation of the fuel system or its associated readings. When the aircraft was returned to service after the incident, there were no anomalies or problems similar to those that occurred during the incident.

As for the consumption, the calculations revealed that the consumption values of the engines on aircraft EC-LHB were within the normal operating range. No significant deviations capable of having an effect on the incident were identified. Specifically, the aircraft logs both before and after the incident showed an average consumption value of 35.3 l/h, very close to the 34 l/h specified in the Flight Manual.

Moreover, the profile of the incident flight (cross-country flight, versus practicing maneuvers or low-altitude flights) is within the standard fuel consumption profiles.

Therefore, the following four factors are ruled out as having caused the incident.

- Error in the fuel gauge Reading.
- Leaks, breaks or improper operation of the fuel system.
- Abnormally high consumption by the engines.
- Excessively demanding flight profile in terms of fuel use.

Once these factors are ruled out, the first option is impossible. As a result, the analysis will focus on the second possibility, that the flight was started with insufficient fuel.

2.1.2. Possibility 2: flight started with insufficient fuel

The calculations based, on the one hand, on the aircraft's average fuel consumption and, on the other, on entries from previous flights, yielded consistent results in terms of the fuel present before the flight. It is estimated that the aircraft probably took off with the tanks filled to 75% of their capacity (approximately 152-153 l).

This estimated value is also consistent with the fuel readings that the crew described seeing during takeoff, which were around 165 l (100 l in the right tank and 65 l in the left). Considering the flight time, the taxi time not considered in the calculations and the momentary increase in consumption during the fly-by in Pamplona, it is likely that the aircraft did not take off with enough fuel to complete the flight to the destination.

Even though the aircraft had been refueled just before the flight, theoretically to its maximum capacity, the gauges in the cockpit should have indicated that the tanks were not full, as the crew noticed during the takeoff. As the flight Manual states, the only reliable indicator of the amount of fuel are the cockpit gauges. In fact, the pre-flight inspection does not require a visual check of the amount of fuel, only the drain to detect impurities and closing the fuel cap to avoid fuel leaks. The refueling procedure is manual, and the visual check through the fuel filler is only considered valid for doing very general estimates (tank full, tank empty, etc.), but not for exactly quantifying the amount of fuel. Given the dimensions of the tanks on this aircraft, a change in fuel level of 1 centimeter (which is very difficult to detect) is equivalent to a difference of 6 l (out of 100 l).

Therefore, it is likely that the aircraft was not fully refueled, and even though the student stated that he had visually checked the tanks, this check is limited in terms of being able to reliably determine the exact amount of fuel in the tanks, which can only be done by using the gauges in the cockpit.

Although it has no effect on the incident, a check of the logs revealed some errors in the fuel quantities entered. Specifically, several 100% (FULL) entries were made even though the calculations showed that the fuel quantity was between 85% and 92%.

Based on the information provided by the flight club involving the limitations to fully refueling the aircraft at this airport, the conclusions of the calculations made are clear. The effect of the incline angle of the stand at the Sabadell Airport and the internal design of the tanks, in terms of the fuel supply flow rate, have a negligible effect:

- The effect of the incline angle of the apron is less than 5 l (out of 200 l).
- The fuel flow rate in relation to the design of the tanks has no effect. In addition to the calculations confirming this, if this effect existed, other users would have reported problems fully refueling the tanks, and the manufacturer would have provided the relevant information in the Flight Manual, as this issue would have an effect on flight safety.

Therefore, based on all of the aspects analyzed involving the fuel situation, it is concluded that:

- The aircraft took off with 75% of the total fuel.
- The previous refueling had not fully filled the tanks.
- The incline angle of the stand would have had a very limited effect on the refueling process (2.5% of the full capacity).
- The design of the tanks does not affect the ability to fully refuel the aircraft.

2.1.3. Measures taken by the Aeroclub Barcelona-Sabadell

The measures taken by the Aeroclub Barcelona-Sabadell cover the potential areas to improve identified during the investigation, since:

- they prioritize and note the need to use the fuel gauges as the only reliable indicator of the amount of fuel, and
- they provide an additional safety barrier by modifying the flight times based on the profile of the flight to be carried out in order to account for potential deviations from the standard average fuel consumption.

As a result, following an analysis of the measures adopted by the flight club, any potential safety recommendations that might have resulted from the investigation into this incident are not included in this report.

2.2. Handling of the emergency

The information available to assess how the emergency was handled comes from the radar data, the results of the incident and the crew's statements.

The communications made by the crew during the emergency spanned a period of 18 sec. The first communication reporting the emergency was made with the aircraft at 90

kt and 910 ft AGL, which suggests that by the time this report was made, neither of the aircraft's engines was running. The last report made, in which the crew stated they were landing on a field, also recorded the instructor's command to fully lower the flaps, which confirms his intention to land. The descent rate at that point increased until the landing, and reached a value of -1263 fpm.

Based on the area where the aircraft was found, the vertical speed and its position relative to the last radar returns, the landing is estimated to have taken place at 16:28:50, less than 1 min after the emergency occurred.

Despite the proximity of the Igualada aerodrome, the speed, the AGL and the descent rate of the aircraft would have made reaching the aerodrome difficult, if not improbable. Therefore, the decision to alter the initial decision to land at this aerodrome and find a field is deemed to have been correct.

The field selected was also correct, since it was a level crop field that must have allowed the instructor to make a very smooth landing, judging by the final condition of the aircraft, which was intact.

The only finding of note is the fact that the propellers were not feathered. This step is listed in the procedures in the Flight Manual, and is intended to allow for a longer glide distance. In this case, even though the aircraft was not configured as specified in the Flight Manual (which could be why the descent rate was higher than expected, as reflected in the radar returns and in the student's statement), the instructor, as the pilot in command, made an uneventful emergency landing:

- He declared the emergency and its nature to ATS.
- He reported his intentions.
- Due to the progress of the flight, he altered his initial intention to divert to the Igualada aerodrome.
- He selected a field suitable for landing.
- He made a smooth and controlled landing that caused no damage to the aircraft.

Finally, there is nothing worth noting in terms of the handling of the emergency by ATC. The information was relayed to emergency services and to the Igualada aerodrome proactively and without delay, and ATC looked for an alternate way to locale the aircraft by resorting to another aircraft that was flying in the vicinity.

3. CONCLUSIONS

3.1. Findings

General:

- The aircraft had a valid certificate of airworthiness.
- The aircraft had all the permits and clearances needed for the flight.
- The crew had all the permits and licenses needed for the flight.
- It was a training flight with dual control as part of an ATPL(A) course.
- Weather conditions were suitable for visual flight.

About the flight:

- The aircraft had been refueled before the flight.
- The flight consisted of a segment from Sabadell to Pamplona, a fly-by in Pamplona and a return flight to Sabadell.
- The fuel consumption was not significantly higher than the average specified in the Flight Manual.
- The aircraft did not exhibit any mechanical or operational problems with the fuel system.
- Both engines stopped mid-flight in the vicinity of the Igualada aerodrome.
- The crew declared a MAYDAY to ATC and reported their intentions.
- The crew made an emergency landing in a crop field.
- ATC services handled the emergency properly and proactively.
- The crew were not injured and the aircraft was undamaged.

3.2. Causes/Contributing factors

The incident of aircraft EC-LHB was likely caused by the failure to adhere to the refueling procedures in the Flight Manual, which caused both engines to stop mid-flight due to fuel starvation.

4. SAFETY RECOMMENDATIONS

None.