

DATA SUMMARY

LOCATION

Date and time	Monday, 11 July 2011, 21:00 local time
Site	San Carles de la Rápita (Tarragona)

AIRCRAFT

Registration	EC-JLB
Type and model	AIR TRACTOR AT-802A
Operator	SAETA (Servicios Aéreos Europeos y Tratamientos Agrícolas)

Engines

Type and model	PRATT AND WHITNEY PT6A-67F
Serial Number	1

CREW

Pilot in command

Age	48 years old
Licence	Commercial pilot license
Total flight hours	2,135 h
Flight hours on the type	157 h

INJURIES

	Fatal	Serious	Minor/None
Crew			1
Passengers			
Third persons			

DAMAGE

Aircraft	Minor
Third parties	None

FLIGHT DATA

Operation	Aerial work – Commercial – Fire fighting
Phase of flight	Water landing

REPORT

Date of approval	19th September 2012
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1. FACTUAL INFORMATION

1.1. History of the flight

The amphibious aircraft, an AT-802A, registration EC-JLB, was engaged in firefighting efforts for the government of Catalonia. On 11 July 2011, it took off at 20:30 local time from the Reus Airport, where it was based, loaded with water. It was flying behind another AT-802A, performing all of its maneuvers behind the lead aircraft. After doing the first drop on the fire they were fighting, they headed for San Carles de la Rápita, in Tarragona, to take on water and return to the fire.

At 21:00, while taking on water, the aircraft suffered an accident due to the fact that the gear was extended. The aircraft turned over and remained floating on the surface upside down. The pilot waited for the cockpit to fully flood, took the air bottle and left the aircraft under his own power without sustaining any injuries. The aircraft suffered minor damage to the left aileron and the propeller blades.



Figure 1. EC-JLB before and after being recovered from the water

1.2. Personnel information

The pilot had flown the aircraft on the positioning flight from Carcelén (Albacete) to the Reus Airport on 28 June 2011. He started working on firefighting operations on 4 July from that base and had flown on 4, 5 and 7 July 2011. He had flown 73 hours in the last year, 11:50 h in the last quarter, 8:40 h in the last month and 4 h in the last week.

He had a total of 2,135 h of experience. He had obtained his rating to fly the amphibious Air Tractor 802 in May 2005, a rating he last renewed in June 2011. In May 2011 he had renewed his terrestrial and agricultural Air Tractor rating. In January 2011 he had completed the company's annual proficiency check.

He had 157 h of experience on the amphibious Air Tractor. His most recent flights on that aircraft type had been on 4, 5 and 7 July, the positioning flight on 28 June, the rating renewal flight on 2 June and the year before between June and November.

The pilot's main activity was firefighting.

1.3. Aircraft information

Aircraft EC-JLB had been manufactured in 2005 and registered in Spain in December of that same year. It had all of the licenses and authorizations required to fly. At the time of the accident the aircraft had 285 h and the engine 302 h.

On 14 June 2011, approximately a month before the accident, the aircraft passed its annual and 100-hour inspections, and the propeller and engine present on the aircraft at the time of the accident were installed. The pontoons were also subjected to their annual and 100-hour inspections, during which all of their components, including the gear's electrical system, were checked. Following this maintenance, the aircraft flew a total of seven hours, corresponding to the positioning flight to the base at Reus and the flights of 4, 5 and 7 July as part of the firefighting campaign, all by the accident pilot.

1.3.1. Description of landing gear

The undercarriage (see figure 1), which has two nose gears and two main gears, all of them retractable and housed in the pontoons, is operated via two independent hydraulic systems. Each system can actuate the gear by itself. There are two hydraulic pumps, each driven by an electric motor. The two pumps normally run simultaneously for faster gear operations. Once the gear reaches the desired position, it is locked in place mechanically.

The position of the gear is not visible from the pilot's seat but is indicated in the cockpit by eight lights located to the right of the gear lever (figure 2, left photograph):

- 4 green lights that indicate the gear is up and locked when on.
- 4 blue lights that indicate the gear is down and locked when on.
- 2 red lights (PUMPS ON), located between the green and blue lights, that, when on, indicate the pumps are running and the gear is in transit.

When the gear is up and locked, the gear up lights turn on and remain on as long as the gear remains in that position. In other words, once the gear is raised, the 4 green lights in the cockpit will be on. The same logic applies to the gear down lights. While

in transit, the gear up and down lights are off and the pump lights turn on, indicating that the pumps are on and that the gear is moving.

Associated with each of the electric motors that drive the two hydraulic pumps are two circuit breakers, identified as PUMP 1 and PUMP 2, that protect the circuit from overloads (figure 2, right photograph). These breakers, one for each motor, are in the right panel in the cockpit.

The hydraulic pumps also extend and retract the scoop nozzles. When the airplane is stable on the water and moving at a preset speed, the scoop nozzles are extended. With regard to the conditions of the gear, the pumps are energized when the hydraulic pressure in the system is below a set value. This occurs when the gear lever is actuated. According to information provided by the manufacturer, a frequently operating pump when the gear is not in transit is indicative of a hydraulic leak, a situation that is covered by an emergency procedure. In flight, the pressure in the system may occasionally drop due to the system being idle, in which case the pump may turn on for one or two seconds.

The gear is locked in the up or down position mechanically and does not require hydraulic pressure to stay in position. Once the gear is locked, it will remain in the locked position.

There is an acoustic system to aid pilots in determining the gear position. When the aircraft's speed drops below a set value, the system, protected electrically by the GEAR ADV breaker, announces "GEAR IS UP FOR WATER LANDING" or "GEAR IS DOWN FOR RUNWAY LANDING" every 3.5 seconds. At the same time an amber light turns on in a pushbutton situated to the left of the panel. When the pilot presses this button, the acoustic notification stops.

The electric motors for the pumps and the acoustic gear notification system are powered from the main bus.

1.3.2. *Operating procedures involving the landing gear*

There are repeated warnings in the manual prohibiting a water landing if the gear is not fully retracted. There is also a requirement to install a placard on the control panel within view of the pilot featuring this same warning.

Item 24 on the before engine start checklist includes a check of the breakers. After takeoff the gear UP position and the four blue lights are checked on three separate occasions: during the climb, in cruise flight and on the approach to take on water.

There are no steps in the normal procedures in the flight manual that require operating the pump motor breakers. Such actions are only contained in the emergency procedures (in the event of continuous pump operation in flight or of a gear failure).

1.4. Wreckage and impact information

There was minor damage to the aircraft's left aileron and propeller blades, indicative of an impact at low speed. The landing gear, which had been visually confirmed as being down before the recovery, was confirmed to be locked. The aircraft was placed on the gear once it was recovered from the water.

In the cockpit the gear lever was correctly situated in the gear up position and the circuit breakers for the hydraulic pump motors (labeled PUMP 1 and PUMP 2) were tripped. The gear extension lever was guarded, the propeller lever was in the forward position, the flaps were extended 20° and the water scoop system was in manual. The GEAR ADV breaker associated with the acoustic notification for the gear was not tripped.

Next to the water refill selector there was a sticker with the word GEAR handwritten on it in Spanish.



Figure 2. Gear lever in the UP position and tripped gear pump breakers

1.5. Tests and research

1.5.1. Statements

Pilot's statement

In his initial statement, the pilot said that after takeoff, he raised the gear and did not actuate the gear lever for the rest of the flight, since he did not need to do so until the

landing. He took off in the number two position, behind another aircraft. The pilots, of their own initiative and as a safety measure, had agreed to perform the checklists from memory and check them out loud on a separate frequency. He, by virtue of flying in the second position, was able to check the position of the gear of the aircraft flying ahead of him, but not the other way around. He stated that the lights were on and that no acoustic warnings sounded.

In a subsequent statement he said that he was not sure whether the gear lights were on, but he was positive he had raised the gear after takeoff. At the start of the flight he had had problems with the radio (the other aircraft was not receiving him) which they eventually solved. He said that although it was not mentioned in the procedures, he was in the habit of opening the pump breakers when preparing for a flight since the pumps turn on as soon as the aircraft is powered up and can be very bothersome.

Statement of the pilot flying in front

The mechanics do a check first thing in the morning and then they do a pre-flight check. In his check of the cockpit, he does not make any adjustments to the hydraulic pump breakers. He always activates the gear lever immediately after takeoff and then again only at the end of the flight. He took off in front, made his water drop and supervised the drop made by EC-JLB. He did not notice whether its gear was down. In his opinion, he would have noticed whether the gear was down because the nose gear is visible even in the air.

1.5.2. *Inspection of landing gear*

Once the aircraft was recovered from the water, the gear was inspected visually. There were no signs or physical evidence of any equipment being damaged, broken, bent or of a lack of clearance indicative of a physical problem with the mechanism used to lower or raise the gear. The gear lever in the cockpit did not show signs of being loose or of being able to be moved inadvertently from its position. There was hydraulic fluid in the system and no leaks or losses of fluid were detected. The overall appearance of the aircraft and gear was good.

The gear was physically in a down and locked position. None of the gear's components had started to move upward. In fact, the airplane was placed resting on its gear after it was recovered from the water.

After the accident the gear was tested and verified to cycle through an extension and retraction cycle normally. Both the gear up and locked and gear down and locked indications functioned properly.

1.6. Additional information

1.6.1. *Information from the company*

According to information provided by the operator and confirmed by the pilots, the checklists used are those contained in the manufacturer's flight manual. There are no company-adapted lists. These lists occupy a total of seven pages. The items on each list are unnumbered and the font size is 7. As a general rule, the pre-flight check is conducted in accordance with the Flight Manual by the pilot.

2. ANALYSIS

The accident of aircraft EC-JLB while performing a water landing occurred because the landing gear was down when it should have been up. Under these conditions, the aircraft's reaction to turn over and remain afloat upside down is an expected consequence. This kind of occurrence is typical for amphibious aircraft, as evidenced by the warnings in the flight manual and in the cockpit and by the gear position warning systems that have been designed specifically for this type of aircraft.

With the exception of the position of the gear and the hydraulic pump breakers, the flaps, power, propeller and gear levers were all in the proper position for a water landing. The minimal damage to the aircraft is consistent with a low landing speed, as required by a water landing.

2.1. Gear position

The gear lever was firmly slotted in the gear up position. That the lever moved either due to being improperly housed in its slot or to being inadvertently moved by the pilot can be ruled out. It is also considered unlikely that the pilot altered the lever's position once in the water; that is, that the lever had been in the gear down position and that he changed it before leaving the aircraft. In a stressful and dangerous situation such as a flooded cockpit upside down in the water, it is improbable that the pilot would have taken the time and effort to change the position of any control. Therefore, it is believed that before the water landing, the gear lever was in the up position, just as it was found.

One possibility is that the lever was placed in the gear up position just before the water landing, so that the gear did not have time to fully cycle. The hydraulic pump motors would have turned on to move the gear and the contact with the water with the motors running would explain why the breakers were found tripped after the accident. However, the gear retraction cycle, even if not completed, should have at least started, and in the case of EC-JLB, none of the gear components showed signs of moving toward the retracted position. Thus, while this hypothesis does explain the position of the breakers and gear lever, it does not account for the gear position.

According to his statement, the pilot was completely sure that he raised the gear after takeoff because that is his usual practice. Once the gear is up, the pilot forgets about it since no further actions with the gear are necessary until the pilot returns to base. If the gear had been retracted after takeoff, the mechanical lock would have kept the gear in that position, even after a loss of hydraulic fluid. After the accident, none of the gear components were damaged, broken or bent or exhibited a lack of clearance indicative of an uncommanded gear extension due to problems in the locking mechanism. The gear up and gear down cycles performed confirmed the proper operation of the locking mechanisms. Problems with a loss of pressure due to hydraulic fluid leaks were also ruled out. Moreover, after the complete inspection of the pontoon system a month before the accident, the aircraft operated for seven hours and four days without any gear extension or retraction problems. There is thus no evidence that the gear could have unlocked, lowered and then relocked itself.

If the possibility that the gear was retracted at some point during the flight is ruled out, the possibility still remains that the gear was never physically retracted and remained in the down and locked position throughout the flight. Since the gear retraction system did not show any signs of malfunctioning, the fact that the breakers were tripped at the start of the flight would explain why the gear did not show any signs of moving toward the retracted position. With the breakers tripped, the pilot probably actuated the lever after takeoff, as was his habit, but the gear position did not change because the pumps were disabled.

The gear cannot be seen from the cockpit and after takeoff, the pilot did not need to use the hydraulic system until he was in the water to refill the tank. That is why, during the flight, there would have been no systems that required hydraulics and that would have alerted him to the inoperability of the hydraulic pumps.

The pilot did not report any problems with the other onboard equipment during the flight. The problem with the radio transmissions at the start of the flight is unrelated with the status of the pump breakers. Only a general fault of the main electrical bus would have resulted in a multiple failure, which would have produced faults in other systems powered by the same bus. Thus, an electrical fault can be ruled out as the cause of the breakers being tripped.

It seems very likely, then, that the breakers were opened at the start of the flight by the pilot while preparing for the flight.

2.2. Gear position indications in the cockpit

Even though the position of the gear is obstructed from the pilot's view, there are systems to aid and notify the pilot of its position: the gear indication lights and the

gear position warning system. Indicating lights are always on, whether it is the up lights, the down lights or the pump running lights. On the accident flight, even if the pumps were not energized, the green gear down lights should have been on throughout the flight and the pump lights off since the breakers were tripped. The tests conducted on the gear after the accident showed that both the gear up and down indications were working properly, thus ruling out any problems related to the cockpit indications.

In addition to the lights, the gear position warning system was operational, since there were no faults with the power supply and the breaker for the system was not open. The system should thus have worked on the accident flight, meaning the pilot should have received the acoustic "GEAR IS DOWN FOR RUNWAY LANDING" warning and seen the warning light turn on.

In conclusion, no signs of a malfunction were found in the visual and acoustic gear position indicating systems, meaning they must have been operational during the accident flight.

2.3. Checklists and execution

The checklists used by the operator are the same as those included by the manufacturer in its flight manual. These lists do not include checks of additional systems, such as the acoustic gear position warning system, which involves a set of checks before the flight. As a result, a safety recommendation is issued to the operator to include the specific systems found onboard an aircraft in that aircraft's checklists. Also, the design of the lists is considered to be inadequate in terms of the ease of execution in flight due to the font size and the lack of numbered items.

The position of the pump breakers should have been detected by the pilot before takeoff as part of the pre-start checklist. Once airborne, the execution of the checklists should have alerted him on three separate occasions that the visual indication for the gear was not appropriate for a water landing.

The fact that the gear lever was in the proper position probably made the pilot pay less attention to the indicating lights, believing the gear to be in the right position because the lever was. Operations do not require actuating the lever once the gear is raised after takeoff. This makes it easy to ignore this system and focus on the firefighting activities.

The practice of opening the pump breakers before takeoff to avoid noise from the pumps while preparing for the flight is not mentioned in the manufacturer's or operator's procedures. It is a customary action performed by the pilot. Even so,

completing the checklists would have alerted the pilot to the improper position of the breakers.

Lastly, the fact that the indicating lights were not noticed on three separate occasions indicates, at a minimum, that the checklists are not completed. In this regard a safety recommendation is issued to the operator to enhance the training it gives its pilots on the need to execute the checklists scrupulously and methodically. The operator should also assess whether the poor design and content of the checklists is the reason why the pilots do not execute them.

3. CONCLUSION

3.1. Findings

- The pilot was properly licensed and rated to engage in firefighting activities.
- The pilot had over 2,000 flight hours and was a full-time firefighting pilot.
- The pilot had 157 h on the AT802A and had 7 h on the aircraft in the last month.
- The aircraft was properly licensed and authorized to engage in firefighting activities.
- A month before the accident the aircraft had undergone annual and 100 h inspections.
- The pilot had seven hours of flight time on the aircraft after its last inspection.
- The aircraft's speed during the water landing was correct.
- The aircraft landed on the water with the gear down.
- The gear lever was properly situated in the gear up position.
- The two hydraulic pump breakers were tripped.
- The visual and acoustic gear position indicators did not exhibit any malfunctions.
- The gear retraction, extension and locking system did not exhibit any malfunctions.
- The tank had a proper amount of hydraulic fluid.
- The checklists were not completed during the flight on at least four occasions.
- The operator's checklists did not include the revision to the acoustic gear position warning system since it was an additional system.

3.2. Causes

Aircraft EC-JLB performed a water landing with the gear down possibly due to the fact that the hydraulic pump breakers were opened so as to avoid the associated noise in the cockpit during the flight preparation, an action not indicated on the checklists. This rendered the gear inoperative, leaving it in the down and locked position for the entire flight. Neither the condition of the breakers or the visual gear down and locked indications were noticed by the pilot during the flight due to the incomplete execution of the checklists.

4. SAFETY RECOMMENDATIONS

REC 38/12. It is recommended that SAETA (Servicios Aéreos Europeos y Tratamientos Agrícolas), as the operator of the flights, and concerning the checklists:

- Enhance its pilot training with regard to the need to execute the checklists as an important safety element that aids in ensuring that the airplane is properly configured, and also bearing in mind that it is a single-pilot operation.
- Analyze the suitability of the checklists used as a possible reason for the routine pilot practice of not completing the lists during operations. The review should at least consider aspects such as the font size, the numbering of items and the amount of items on each list.
- Adapt the checklists to the additional equipment installed onboard each aircraft. Specifically, with regard to aircraft EC-JLB, the checks made prior to the operation of the gear position warning system should be included.

