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SAFETY INVESTIGATION REPORT

Accident to the BEECH - 18 - 3TM registered G-BKGL on 14 September 2021 at Vescovato (Corsica)

Time	Around 10:25[1]
Operator	Private
Type of flight	Post maintenance functional check flight
Persons on board	Pilot[2] and two passengers
Consequences and damage	Pilot and front passenger seriously injured, rear passenger injured, aeroplane destroyed
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in December 2022. As accurate as the translation may be, the original text in French is the work of reference.	

Engine shutdown and reduction in rpm of second engine at end of downwind leg, forced landing near airport, fire

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements made by the occupants, radio-communication recordings, radar data and video surveillance footage from the airport.

History of ferry flight

On 19 August, the pilot travelled to Saudi Arabia accompanied by the aeroplane's designated technician to ferry the aircraft to the United Kingdom via Egypt, Crete, Greece, Croatia and France. On 25 August, en route between Croatia and France, they had to divert to Bastia airport following a reduction in oil pressure on the right engine. The reduction in oil pressure was due to a leak arising from the rupture of cylinder No 5. The aeroplane was parked on the tarmac for several days while waiting for the spare parts that the technician went to collect on 12 September, from his workshop in the United Kingdom. On 13 September, the technician replaced the cylinder and topped up the oil in both engines.

[1] Except where otherwise indicated, the times in this report are in local time.

[2] In this report, the term "pilot" designates the member of the company responsible for bringing the aeroplane back to the United Kingdom. The term "passenger" designates the new owner of the aeroplane sat in the front right seat next to the pilot. The term "technician" designates the mechanic who inspected the aeroplane in Saudi Arabia and who carried out all the necessary ground maintenance work during the journey.

History of accident flight

On 14 September, the pilot took off at 10:10 from Bastia-Poretta airport (Corsica), in the company of the new owner in the front right seat and the technician in the rear seat in order to carry out a functional check flight following the work carried out the day before. At 10:16, the pilot reported to the controller that he had completed the checks and asked for authorisation to return to the airport (see Figure 1, point ❶). Due to an IFR flight departing from runway 34, the controller asked him to follow the mountains to return to the airport[3] and then join the LH downwind leg for runway 34 (see Figure 1, point ❷). At 10:23, the pilot reported that he was on the downwind leg (see Figure 1, point ❸). At the end of the downwind leg, the right engine shut down followed around 20 s later, by a reduction in the power of the left engine. The pilot turned onto the base leg and reported the shutdown of the right engine over the radio (see Figure 1, point ❹). The aeroplane quickly lost altitude with a vertical speed of between -900 and -1,500 ft/min. Too far from the runway, the pilot was obliged to land outside the airport perimeter. Just before touchdown, the aeroplane struck trees. After the aircraft had come to a halt, a fire broke out; the pilot and technician evacuated the aeroplane. The passenger had difficulties releasing his seatbelt and evacuated a few moments later. They then waited for the emergency services which took charge of them around 10 min later.

[3] The airport is situated at an altitude of 26 ft. The airport circuit can be flown from the west over terrain on “authorisation”, at the same altitude as the published circuit over the sea (1,000 ft).

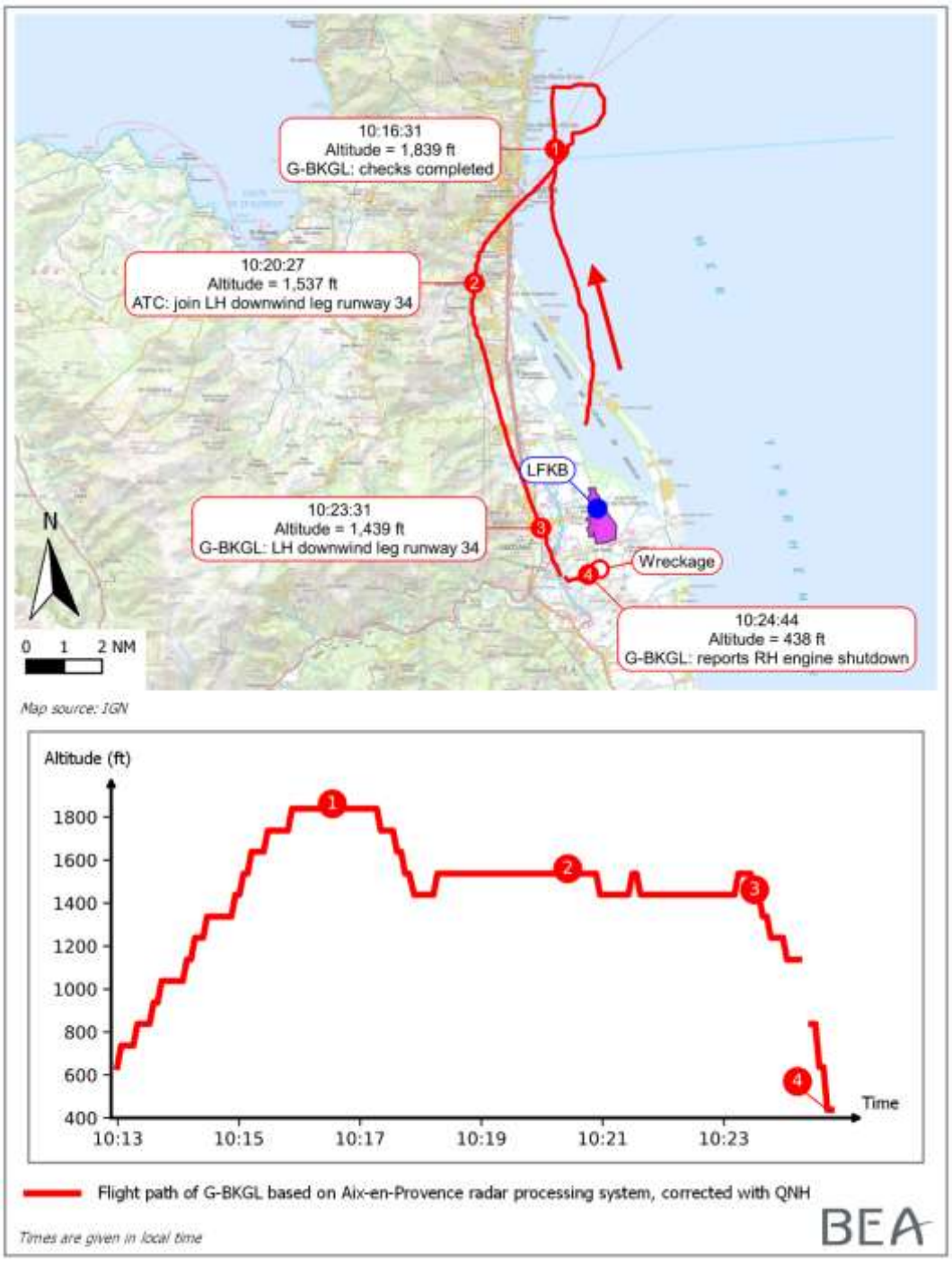

Figure 1: accident flight path

2 ADDITIONAL INFORMATION

2.1 Wreckage and impact information

The wreckage was located in a mandarin grove at around 1,200 m south of the runway 34 threshold. The examination of the site showed that with its wings level, the aeroplane struck a line of trees around 10 m tall while following a straight downward path on an east heading. The aeroplane then banked to the right, its right wing and engine were torn off on striking mandarin trees and then the ground. The fire which subsequently broke out destroyed the aeroplane (see Figure 2).

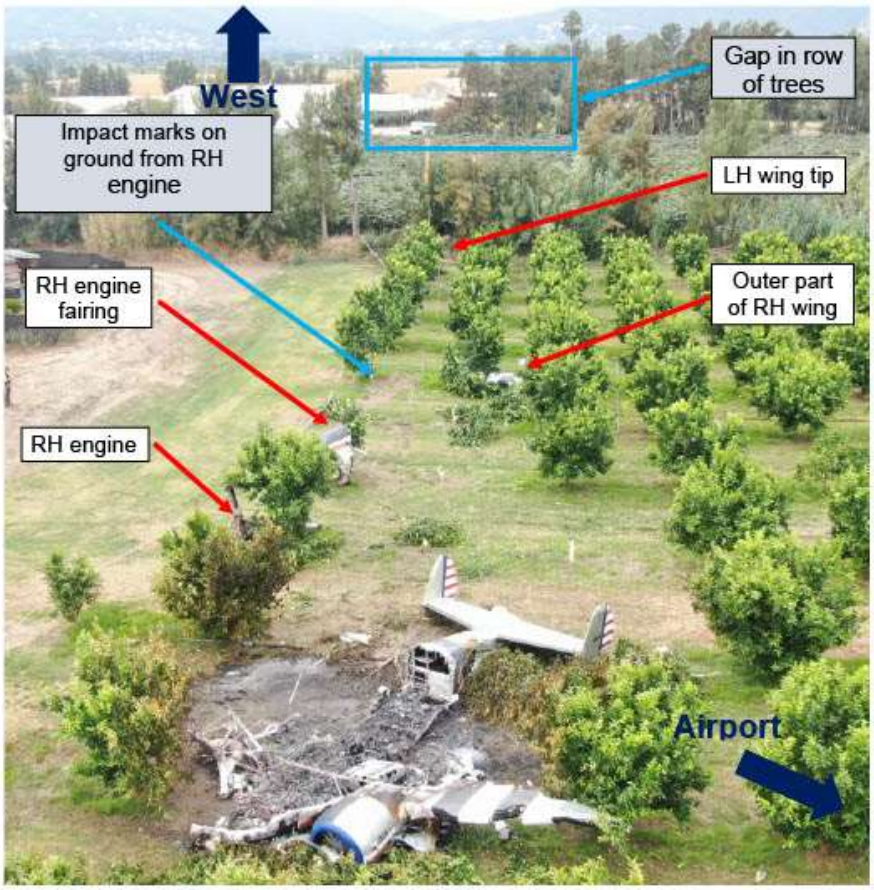

Figure 2: general view of accident site (source: Air transport police (GTA))

The examination of the wreckage which was limited due to the extent of damage to it, did not find any technical failure prior to the collision with the trees and the ground. On raising the wreckage, it was observed that both engines rotated without friction points. The two propellers were rotating at the time of impact without there being obvious evidence of power.

The fuel system was continuous between the LH (main) front tank, the LH (auxiliary) rear tank and the left selector. The five fuel tanks were damaged. Due to the fire damage, it was not possible to check the continuity of the rest of the system nor to determine the position of the cross-feed control located under the front right seat. The two fuel selectors were found in the “Nose Tank” position (refer to paragraph 2.4).

A portable fire extinguisher was found outside the wreckage. It had not been activated.

2.2 Meteorological information

The French met office (Météo-France) estimated the meteorological conditions at the time of the accident as being: wind from 165° of 6 kt, visibility greater than 10 km, clear sky to few clouds, temperature 21°C.

2.3 Occupant information

The pilot was 56 years old. He held a Commercial Pilot Licence (CPL(A)) issued in 2014. He declared that he had flown a total of 4,000 flight hours on various vintage aeroplane models (in particular 1,000 h on aeroplanes equipped with radial engines) including 15 h on the Beech 18. He had logged 40 flight hours in the previous three months, including 15 hours on type. He explained that before leaving Saudi Arabia, he had had 15 h of theoretical ground training on the specificities of the Beech 18 with an instructor and had renewed his Multi-Engine Piston (MEP(A)) rating on 4 September 2021 on a Cessna 340[4].

The 61-year-old passenger held an aeroplane Private Pilot Licence (PPL(A)) issued in 1987; his MEP(A) had been renewed on 4 September 2021 on a Cessna 340. He had logged 1,623 flight hours including 2 h 30 min in the previous three months. He had no experience on the Beech 18 and had planned to obtain his qualification in the following months. He had read the flight manual and during the accident flight, took charge of the radio, at the pilot's request.

The 51-year-old technician had managed the aircraft maintenance workshop since 2004. This workshop had been responsible for the maintenance of G-BKGL since August 2021. He was the designated mechanic of the aeroplane and had inspected it when it was picked up in Saudi Arabia. He was the only person who had carried out work on it subsequently.

2.4 Aircraft information

The aeroplane was owned by a company who had sold it to a private individual in the United Kingdom. The sale was to be concluded once the aeroplane had left Saudi Arabia where it had been stored and was back in the United Kingdom.

2.4.1 Description of Beech D18S fuel system

The aeroplane is equipped with two Pratt & Whitney Wasp Junior R-985-APS4 piston engines and five fuel tanks (see Figure 3) providing a total usable capacity of 234.5 imperial gallon ((imp gal) i.e. 1,066 l):

- A nose tank with a capacity of 66.5 imp gal (302 l), capable of simultaneously supplying the two engines.
- In each wing, main left and right front tanks of 63 imp gal (i.e. 286.5 l) as well as auxiliary left and right rear tanks of 21 imp gal (95.5 l).

[4] According to the United Kingdom Civil Aviation Authority (CAA UK), a MEP rating is sufficient to fly a Beech 18 subject to having followed ground training with an instructor with respect to the specificities of the aeroplane.

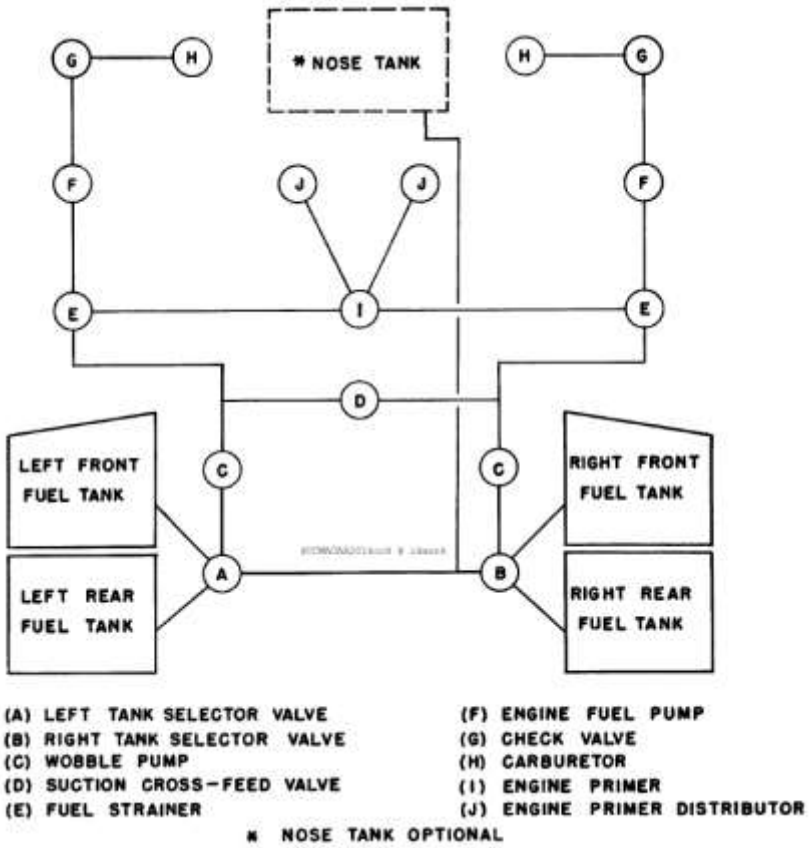

Figure 3: diagram of fuel system
(source: G-BKGL manufacturer flight manual)

Each engine is fitted with a mechanical pump. The aeroplane does not have an electric pump but each engine is equipped with an emergency manual wobble pump (see (C) Figure 3) operated by a common lever. A cross-feed situated downline of the selectors (see (D) Figure 3) can be used to supply both engines from a same tank (front or rear). The cross-feed control is situated under the front right seat.

Two selectors and the cross-feed (see (A) and (B) Figure 3, Figures 4 and 5) control the fuel supply to the engines. The role of the selectors is to manage the fuel supply to each engine and allow the pilot to choose one of the four following positions:

- Left ENG OFF and right ENG OFF (red sector), selector at top;
- Left front and right front (green sector), selector positioned inwards;
- Left rear and right rear (black sector), selector at bottom;
- Nose (yellow sector), selector positioned outwards.

The flight manual specifies that the pilot must check that the front fuel tanks are selected before starting up the engines. It should be noted that the selector positions for the nose and front tanks are opposite each other, 180° apart. Furthermore, the ergonomy of the selector handles might lead the pilot to place the handle in the opposite position to the correct one. In these conditions, it is possible to accidentally select the nose tank instead of the front tanks.

A fuel pressure indicator is associated with each engine. There is no low fuel pressure warning light on the instrument panel.

The aeroplane is equipped with a single fuel quantity indicator situated on the bottom left-hand side of the instrument panel. Under the indicator, there is a five-position selector to choose a fuel tank and display the quantity of measured fuel in the tank. The scale of the indicator is in tenths of the total capacity of the selected tank.

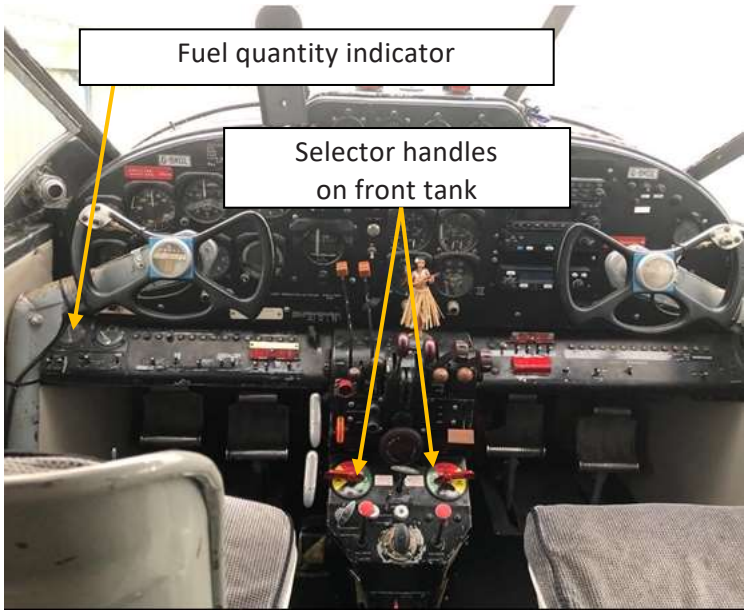

Figure 4: position of selectors and fuel quantity indicator (source: Alastair Goodrum, annotated by the BEA)

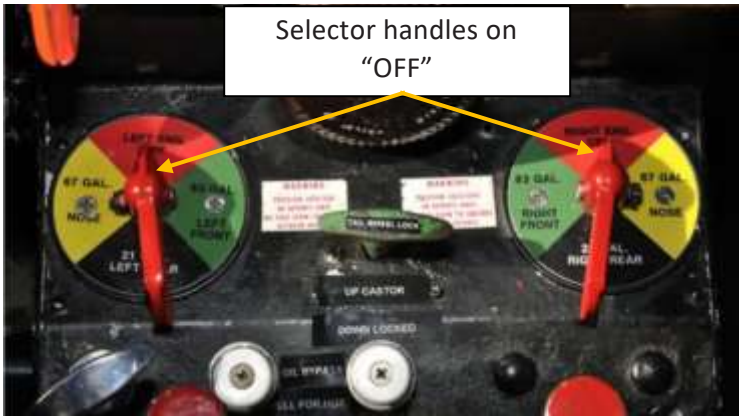

Figure 5: examples of positioning of fuel selectors in OFF position (source: Pilot, annotated by the BEA)

2.4.2 Consumption and management of fuel during flight

The manufacturer’s flight manual requires the pilot to position the selectors on the front tank for the engine start-up, take-off, approach and landing. Furthermore, it is specified that the take-off and landing should be performed on the front tanks unless the remaining quantity of fuel is insufficient. In flight, the tank selection sequence is: nose, rear and then front.

The pilot indicated that he checked the fuel gauge during the pre-flight inspection. He remembered having read between 1/10th and 2/10th for the nose tank[5], and half full for each front tank and considered that he had a remaining endurance of 1 h 20 min. He indicated that he started up, carried out the engine checks and took off on the front tanks and did not move the selectors during the flight.

During previous flights, he had always taken off and landed on the front tank and changed the tank selection according to needs but was not able to specify how many times and at what frequency.

The log book was destroyed in the fire. According to the pilot and the technician, the average consumption of each engine was between 80 and 90 l/h (i.e. between 160 and 180 l/h in total) and the aircraft was last fully replenished with fuel on 25 August in Croatia, before take-off. The aircraft had flown 2 h 45 min between this refuelling operation and the time of the accident. It was not possible to determine the distribution of the remaining fuel in the tanks at the time that the right engine shut down.

Given the gauge indications described by the pilot, the fact that they carried out engine checks for 15 min and the duration of the accident flight (13 min), the estimation of the total fuel quantity consumed by the two engines is as least 40 l. If the pilot accidentally took off on the nose tank in which there was no more than 1/10th to 2/10th of fuel (i.e. between 30 and 60 l), it is very probable that the fuel supply system of the two engines was unprimed.

2.4.3 Emergency procedures

If the indicated fuel pressure decreases, the flight manual requires the pilot to select the fullest fuel tank, activate the manual pump to restore fuel pressure and then to inject fuel several times using the primer pump.

In the event of an in-flight engine shutdown, the flight manual requires the pilot to set the corresponding propeller to full low pitch with the power lever on full throttle and the mixture on full rich. Once the engine failure has been identified with certitude, the pilot is asked to reduce the power of the engine with the failure and to feather the propeller, to set the power of the operating engine to 2,200 rpm, and to set the power to idle and the mixture to full lean for the inoperative engine.

In the event of a forced landing, the flight manual indicates that the pilot must decide whether to land with the landing gear down or up and if in doubt, he must land with the landing gear up. The pilot must close the fuel tank selectors, switch off the master ignition switches, extend the flaps and then set the battery and generator to OFF.

[5] Corresponding to a quantity of between 30 and 60 l.

2.5 Statements

The pilot stated that the day before he had taken two Imodium®[6] tablets as he had diarrhoea[7]. The morning of the flight, he had a stomach ache and he was tired as they had stayed up late. On the downwind leg, on reducing the engine power, with the flaps retracted, the fuel pressure indicator for the right engine dropped to zero. The left engine was still providing power. He activated the manual pump lever and observed the absence of pressure on the right engine. He set the left engine power lever to full throttle, asked the front passenger to feather the right propeller and then turned left towards the airport. He did not active the cross-feed as this was located under the front right seat. Initially, he told the BEA that he could not remember having changed the fuel tank selection, then several months after the accident, he indicated that he might have done this by reflex. He then observed that the power of the left engine had decreased to 1,500 rpm[8]. He explained that the controller's instruction to follow the mountains resulted in him extending the runway circuit. Having lost a height of around 500 ft and being too far from the runway, he concentrated on the management of the forced landing. He did not have time to use the primer pump. The aircraft quickly lost height and the pilot realised that he was going to strike the trees ahead of him. When the right engine struck the trees, he saw flames but did not have time to activate the engine fire extinguishers nor to give the safety instructions to the passengers.

The passenger could not remember the technician visually checking the remaining quantity of fuel in the tanks during the pre-flight inspection and that he, for his part, had trusted the pilot about the fuel quantity indicator. During the before take-off engine tests, he could not remember the position of the fuel selectors as he was more concentrated on the instruments concerned by the replaced cylinder. They intended to refuel after landing and before taking off again for their flight to Cannes airport and then the United Kingdom. He explained that each time the aircraft was refuelled, they fully replenished the front and rear tanks and added some fuel to the nose tank which was never completely full. When the right engine shut down, the pilot asked him to feather the right propeller. He feathered the right propeller and did not switch off the battery nor the magnetos. He indicated that 30 s later, the pilot asked him to shut down the engine (without specifying which one) which he did[9]. He added that he did not check the fuel indicator and that he neither moved the cross-feed nor did he select another fuel tank. He just reported the shutdown of the engines on the radio. He specified that since leaving Saudi Arabia, the pilot had become familiar with the check-list and no longer used it.

The technician indicated that it was another pilot with experience on the Beech 18 who was initially supposed to ferry the aircraft with them to the United Kingdom but that they had left without him as he did not have the COVID-related authorizations to leave Saudi Arabia. He specified that the passenger had carried out the exterior pre-flight inspection. According to him, that same morning, the pilot had not looked well but had wanted to continue. He could not remember having seen the latter change the position of the fuel selectors during the flight. He could not remember the value of the fuel pressure indication for the left engine when the power of this engine decreased but he noted that the needle of the left engine tachometer was not on full throttle.

[6] The side effects of this drug are flatulence (1 to 10% of cases), abdominal pain (less than 1% of cases), but also drowsiness and fatigue (at an undetermined frequency).

[7] Diarrhoea can cause dehydration and loss of potassium, which can lead to fatigue, feeling faint or confusion of ideas.

[8] The rating of engines at full throttle is between 2,200 and 2,300 rpm.

[9] The pilot said he did not remember asking him to do this.

2.6 Survival aspects

All three occupants had their harnesses fastened at the time of the accident. The fire broke out in the front right part of the cockpit before the pilot and technician had evacuated the aeroplane unaided. They got out of the plane via the rear left door. They did not think to activate the engine fire extinguishers and did not use the hand fire extinguisher located at the rear of the aircraft as the fire was too large. The passenger also evacuated the wreckage unaided after having encountered difficulties with releasing his harness. The pilot and passenger were seriously burnt.

The witnesses on the ground to the accident did not think to take a fire extinguisher. White smoke and sparks came out of the wreckage, quickly followed by thick black smoke and then flames in the cockpit. They alerted the emergency services by telephone at 10:25.

2.7 Response and coordination of emergency services

Between 05:00 and 23:00, the protection level of the Aircraft Rescue and Fire Fighting service (ARFF) at the airport is level 7 which requires at least two vehicles, four airport responders and a fire officer. At the time of the accident, two ARFF response vehicles, five responders and a fire officer were present.

To notify the ARFF responders, the air traffic controller activated the “crash horn” which indicated a state of alert[10] instead of the siren to indicate an accident[11]. He told them by telephone that the accident had occurred south-east of the airport facilities without specifying if it was in the airport perimeter or in the neighbouring area[12]. In reality, the accident occurred outside the neighbouring area (see Figure 6).

[10] When an aircraft has a failure, or is likely to have a failure that could lead to an accident, ARFF vehicles are deployed to predetermined locations.

[11] When an aircraft accident has occurred or will inevitably occur on the aerodrome or in its vicinity, ARFF resources must be mobilized to contain the accident in a minimum of time.

[12] Land neighbouring the aerodrome perimeter and at such a distance that the action of the ARFF response resources can usefully be envisaged, taking into account the access routes and the performance of these resources. This zone is defined in accordance with the provisions of the Specialized Aerodrome Emergency Plan (SAEP).

Figure 6: excerpt from Bastia Specialized Aerodrome Emergency Plan (annotated by the BEA)

The ARFF vehicles set off one minute later without having any information about the type of aircraft, the number of occupants and the quantity of fuel. They thought that the accident had occurred in the airport perimeter and asked for clearance to pass by the runway to reach the airside grounds south of the airport. The controller then specified that the accident was situated in the neighbouring area. They therefore tried to leave using the "GTA access" gate as it was the quickest way from their position. The gate was closed and no-one being visible to open it, they had to leave through the "PARIF access" gate which extended their response time.

A witness had also alerted the departmental emergency services and given the site of the accident. The first Haute-Corse fire and emergency services vehicle arrived around ten minutes after the accident. According to the head of the ARFF, the absence of radio equipment compatible with that of the Haute-Corse fire and emergency services (ANTARES equipment) meant that the ARFF responders could not exchange with the former who were already engaged, to obtain information about the whereabouts of the accident site. They had to call the departmental fire and emergency operational centre[13] with their mobile telephone but the information regarding the resources engaged and the location of the accident was insufficient. Initially, it was difficult for the airport responders to know if the accident site was north or south of the river Golo which delimits the neighbouring area. They had to carry out a reconnaissance in the neighbouring area using a light vehicle, solely aided by the plume of smoke. One of their heavy-duty vehicles waited for the result of the reconnaissance before heading towards the banks of the river Golo so as not to be blocked on a track or in a dead-end. The first ARFF response vehicle arrived at the wreckage 18 min after the accident.

[13] The departmental fire and emergency services director or a professional or volunteer firefighter command the emergency operations in the neighbouring area.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

Following an in-flight failure on 25 August 2021 which required the crew to divert to Bastia airport, the aircraft was parked for 20 days pending the arrival of the spare parts to replace one of the right engine cylinders. The day before the accident flight, the technician repaired the right engine in the presence of the pilot and the front passenger. The following morning, the pilot, who did not feel well, carried out the interior pre-flight checks. The front passenger carried out the exterior pre-flight inspection. The pilot checked the quantities of fuel remaining in the fuel tanks using the fuel indicator. He considered that the remaining quantity in the main fuel tanks was compatible with the envisaged post maintenance functional check flight and planned to refuel on completing this flight.

The most probable hypothesis is that during the start-up, the fuel selectors were in the “Nose” position. The pilot thought that the front tanks were selected. He probably took off and carried out all the flight on the nose tank shared by the two engines, without being aware of this. At the end of the downwind leg, probably after having used all the available fuel in the nose tank, the right engine shut down. Based on this hypothesis, the left engine would have then suffered the effects of fuel starvation. This hypothesis is consistent with the position of the left and right fuel selectors on “Nose” observed on the wreckage, and the initial statement of the pilot about not having moved the selectors.

The pilot, who was no longer able to hold level flight and being too far from the runway to join it, was unable to avoid the collision with trees during the forced landing. His attention was focused on the aircraft’s flight path and he did not think to cut off the battery and magnetos nor to close the fuel power supply. During the collision with the trees, the right engine and right wing were torn off and a fire broke out.

Contributing factors

The following factors may have contributed to the probable selection of the nose tank rather than the front tanks:

- The pilot’s small amount of experience on type which could have exposed him to making a selection error and did not facilitate this being detected when carrying out the before start-up and before take-off checks.
- The ergonomy of the fuel tank selectors which could have led him to believe that they were positioned on the front tank.
- The pilot’s state of health and fatigue when he carried out the flight which was likely to have impaired his cognitive abilities. A sort of get-home-itis linked to the accumulated delay to repair the cylinder may have contributed to the pilot’s decision not to differ the flight, despite not being in top form.

The pilot’s erroneous mental image of the position of the fuel selectors might have led him not to modify their position when the problem with the engines occurred.

Safety lessons

Interoperability between ARFF and departmental fire and emergency services radio-communication equipment

Following the accident and the difficulties encountered by its personnel in communicating with the departmental fire and emergency services during the response, the acquisition of two ANTARES TPH700 radio sets by the ARFF was decided on. This will facilitate operational communication in real time between the ARFF responding to an occurrence within the airport perimeter, and the departmental fire and emergency services that have to enter the airport grounds, as well as in the neighbouring area when the ARFF intervenes.

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.