# Accident to the CESSNA 210K registered N5767J on Thursday 25 July 2024 at Beblenheim

| | |
|---|---|
| **Time** | Around 17:45[1] |
| **Operator** | Private |
| **Type of flight** | Cross country |
| **Persons on board** | Pilot, passenger |
| **Consequences and damage** | Aeroplane destroyed, persons on board seriously injured |
| This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference. | |

## Fuel exhaustion, forced landing in a field, overturn

### 1 HISTORY OF THE FLIGHT

*Note: the following information is principally based on statements, radiocommunication recordings, radar data and data from the on-board systems.*

The pilot, accompanied by a passenger, took off from Aalborg airport (Denmark) at 13:28 bound for Colmar-Houssen aerodrome. He initially climbed to an altitude of 4,400 ft[2]. En route, the aeroplane flew at an average altitude of around 4,100 ft and its ground speed was around 130 kt. At 17:15, the pilot contacted the Strasbourg FIS to obtain information about the activity in the military zones. The controller informed him that zones R228 were active. The pilot turned westwards to fly around them. Due to the frequency being very busy, the pilot also flew west around Strasbourg Regional Terminal Control and continued his route to Colmar, situated in the south. The pilot contacted the Colmar tower controller at 17:40:41 and reported that he was a few minutes from Haut-Koenigsbourg chateau. Less than one minute later (see **Figure 1**, point 1), the pilot asked the Colmar controller for a landing priority, indicating that he was a bit short on oil. The controller asked the pilot to carry out a direct approach to runway 19 and also suggested that he hold his altitude and then descend and extend the landing gear at the last moment. The data from the on-board systems indicated a decrease in engine power at 17:43:35 (point 3). The aeroplane was then at an altitude of around 3,000 ft. The pilot reported to the controller that the engine was stalling and that he was going to try a long final. The controller suggested to the pilot that he identify a field or a road just in case. Around ten seconds later, the pilot reported his intention to carry out a forced landing on the right-hand side of his flight path.

[1] Except where otherwise indicated, the times in this report are in local time. During the flight, the local time was the same for all the countries flown over (UTC+2).
[2]The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.

The last point recorded by the on-board GPS was at 17:45:35, when the aeroplane was on final at a low height. The landing gear came into contact with the vegetation of a field and then a road (D3) situated before the field chosen for the landing (see **Figure 2**). The aeroplane bounced, turned over onto its back and came to rest in this field.

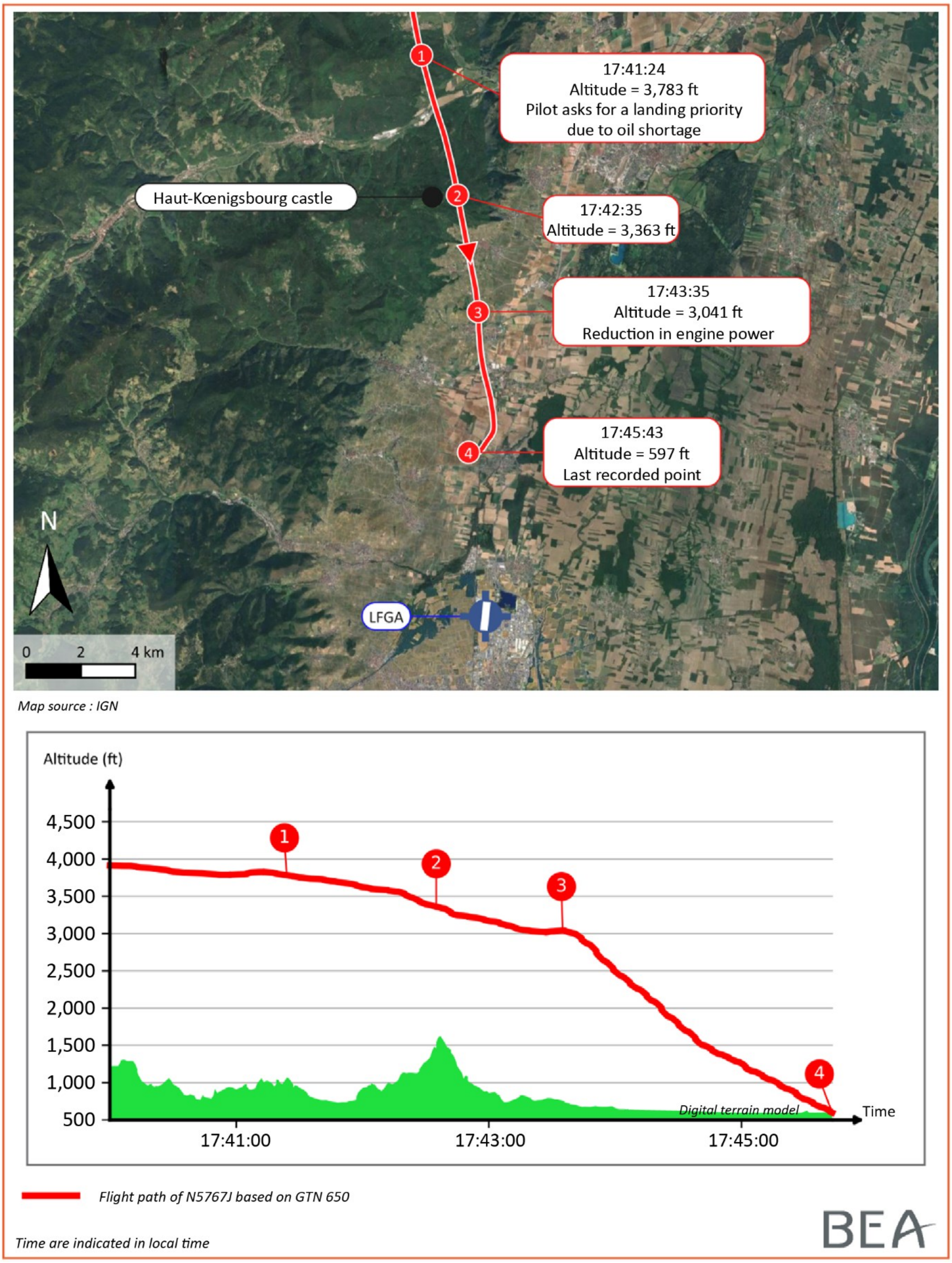


*Figure 1: end of flight path of N5767J*

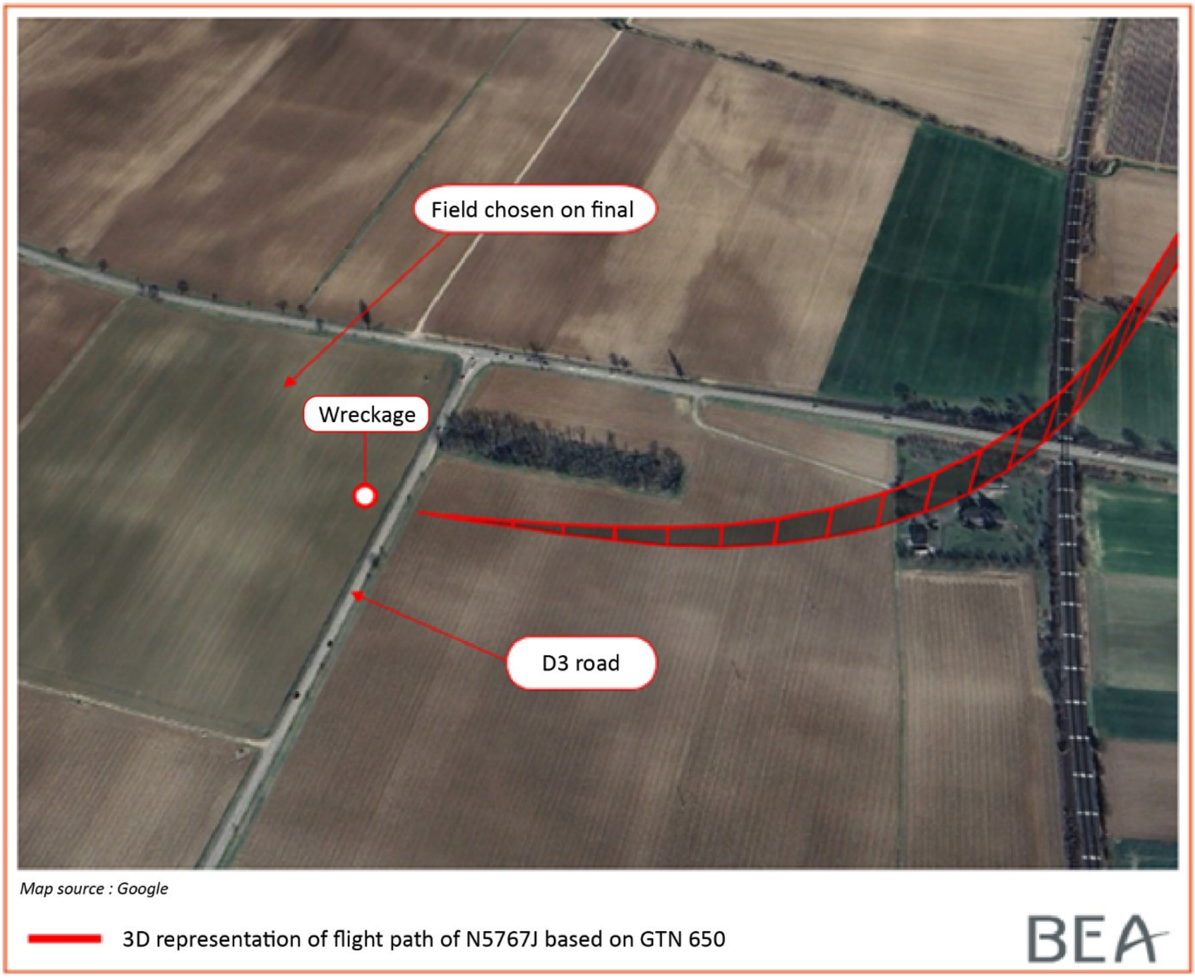


*Figure 2: 3D representation of end of flight path (source: BEA)*

## 2 ADDITIONAL INFORMATION

### 2.1 Aircraft information

The Cessna 210K, known as the Centurion, is a light, single-engine aeroplane with high wings and retractable landing gear. It has six seats and is equipped with a Continental IO-520-L, 6-cylinder piston engine delivering 300 hp.

It is a cantilever wing model (without struts) and has two structural fuel tanks located in the wings. Several compartments in each wing are sealed to serve as fuel tanks, with the upper and lower wing skins respectively forming the top and bottom of the tank. The capacity specified in the flight manual is 45 US gal[3] for each tank. The usable fuel quantity is 44.5 US gal per tank, or 89 US gal in total. The aeroplane does not have a low fuel warning light.

In the event of a forced landing without engine power, if the ground is soft or uneven, the flight manual recommends landing with the landing gear retracted.

[3] Anglo-Saxon unit of volume, the symbol being US gal. A US gallon corresponds to around 3.78 l.


*Figure 3: Cessna 210K registered N5767J (source: photo by Florida Metal, airport-data.com)*

## 2.2 Site and wreckage information

The accident site was situated approximately 6 km north of Colmar aerodrome (marked LFGA in **Figure 1**), at an altitude of approximately 600 ft.

Marks left by the landing gear were visible in the field before the road (D3). The wreckage was lying on its back in a cornfield on the other side of the road. The damage was concentrated at the front of the aeroplane and was consistent with the accident. Two blades were bent backwards, while the third showed no significant deformation. The deformations observed indicated that no engine torque was being transmitted during the sequence that caused these deformations.

The first people to arrive at the accident site reported that they did not smell any significant odour of fuel. Approximately 300 ml of fuel was recovered from the left-hand tank and approximately 600 ml from the right-hand tank.

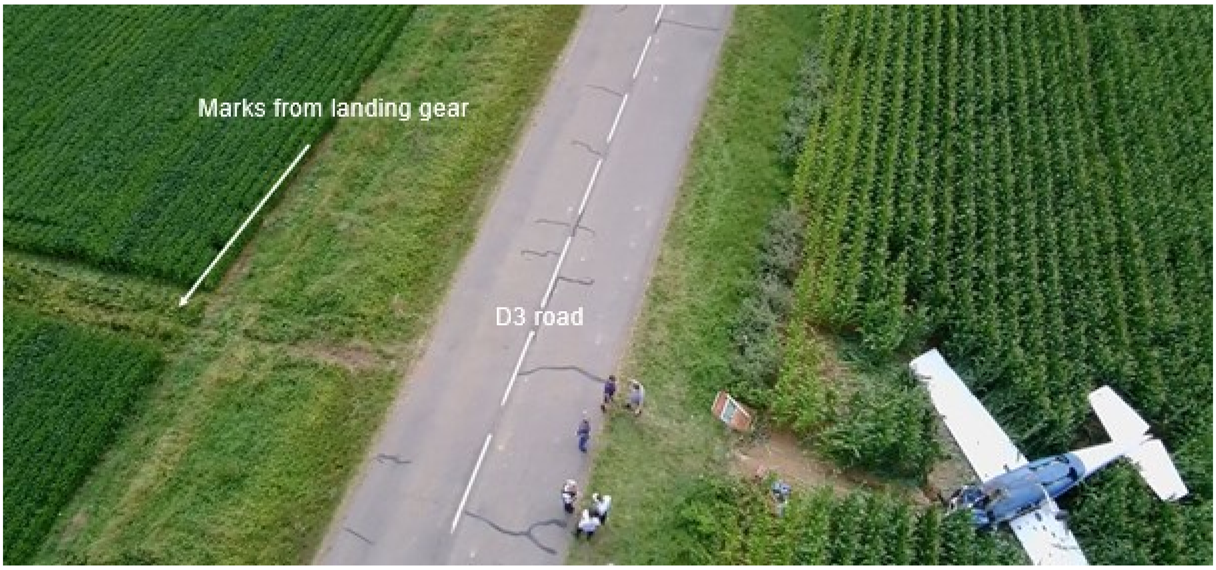


*Figure 4: aerial photo of accident site (source: BEA)*

## 2.3 Examination information

### 2.3.1 Engine and fuel

The examination of the engine did not find evidence of any damage in connection with engine lubrication, and that could have led to a loss of power. The examination of the flow meter did not reveal any anomalies.

The fuel recovered from the tanks had physical and chemical characteristics consistent with those of AVGAS 100LL fuel.

### 2.3.2 Fuel tank

The examinations did not find damage to the fuel tanks. A non-significant leak in the right-hand fuel tank was identified. It was quantified as less than 0.1 US gal for the duration of the occurrence flight.

During the examination of the fuel tanks, it was determined that the maximum quantity of fuel that had been added to each tank was 44.25 gal US gal. These examinations also found that when the aeroplane is not on a horizontal surface, the volume that can be added to each tank may then be reduced by 4 to 5 l (1 to 1.3 US gal).

### 2.3.3 Refuelling and checking fuel quantity

The pilot and owner of N5767J was responsible for the continuing airworthiness of his aeroplane.

In 1994, the FAA issued an Airworthiness Directive (AD) concerning the potential difficulty of replenishing the Cessna 210 fuel tanks. The purpose of the AD referenced 94-12-08 was to prevent a loss of engine power caused by inadvertent fuel loss or inadequate fuel servicing. This directive requires the incorporation of the Pilot Operating Procedures - Preflight Fuel System Quantity Check in the flight manual or aeroplane documents. This check consists of the following steps:

- "*verify that the airplane is level laterally*[4] *and is approximately 4.5 degrees nose up (normal nose strut on a level surface);*
- *visually inspect each fuel tank for fuel level with the upper wing surface when full fuel capacity is intended to be in each tank.*"

The airworthiness directive also specifies calibrating "*the fuel quantity indicating system at the unusable (empty) fuel gauge indication*." This action is not mandatory but if it is not carried out, a placard shall be affixed next to the fuel gauges indicating:

"*FUEL GAUGES NOT CALIBRATED, BASE ALL FUEL CALCULATIONS ON VISUAL INSPECTION, TIME AND CONSUMPTION FIGURES. WITH FULL TANKS, MAXIMUM ENDURANCE IS 4 HOURS FOR FLIGHT PLANNING*."

[4] It is specified that the aeroplane turn and bank instrument may be used to check lateral levelling.

It also recommends replacing the fuel tank caps with raised fuel caps. The raised fuel caps allow the pilot to visually check that the fuel tanks have been replenished as when the fuel is flush with the cap, it is also flush with the top of the fuel tanks. This is not the case with the recessed fuel caps[5] (see **Figure 5**). If the caps are not changed, a placard shall be affixed next to each wing fuel filler opening, indicating:

*"TO ASSURE FULL CAPACITY WHILE FILLING, FILL SLOWLY DURING LAST 5 GALLONS. RECHECK FOR FULL AFTER 2 MINUTES."*

*A Letter to Cessna 210 Owners* from the Cessna Pilots Association, dated January 1996, indicated that, "*it can be difficult to get the last few gallons of fuel in each tank. The tank may appear full when it is actually 5 to 10 gallons short. There have been a number of off-airport landings caused by fuel exhaustion because the pilots thought the tanks had been filled but were actually short of full by a significant amount.*" The letter, referring to the FAA AD, adds that this risk can be reduced by installing non-recessed fuel caps.

The procedure for the Preflight Fuel System Quantity Check in the AD was present in the documents of N5767J. However, the AD was not complied with as regards the following points:

- no raised fuel caps (see **Figure 5**);
- no placard affixed to the wings;
- no placard in the cockpit concerning the fuel gauges;
- no mention in the maintenance documents (before the AD and up to one year after the effective date of the AD) of the calibration of the fuel gauges.

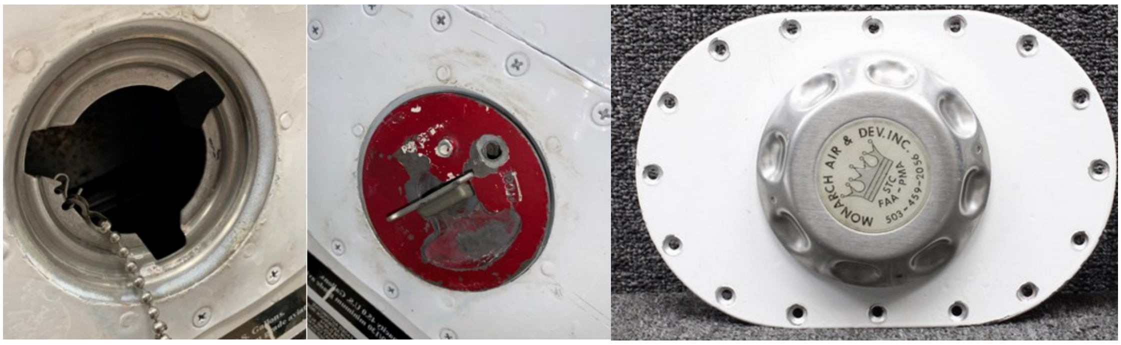


*Figure 5: comparison of fuel caps: LH side and middle, recessed fuel caps installed on N5767J, RH side, raised fuel cap (source: BEA, baspartsales.com)*

## 2.4 Aalborg airport information

Before the flight, the pilot refuelled the aeroplane at Aalborg airport. The refuelling area is a 15 m x 15 m square shown in the figure below. This area is not flat and has a ridge in the centre and two slopes, each with a drain.

[5] The replacement could be carried out as per ***Cessna Service Kit SK210-136***, referenced by ***Cessna Service Bulletin SEB91-10***, dated 25 October 1991, or as per ***Supplemental Type Certificate SA2456CE*** for fuel caps manufactured by Monarch Air & Development, Inc., Assembly No WW-100-2.

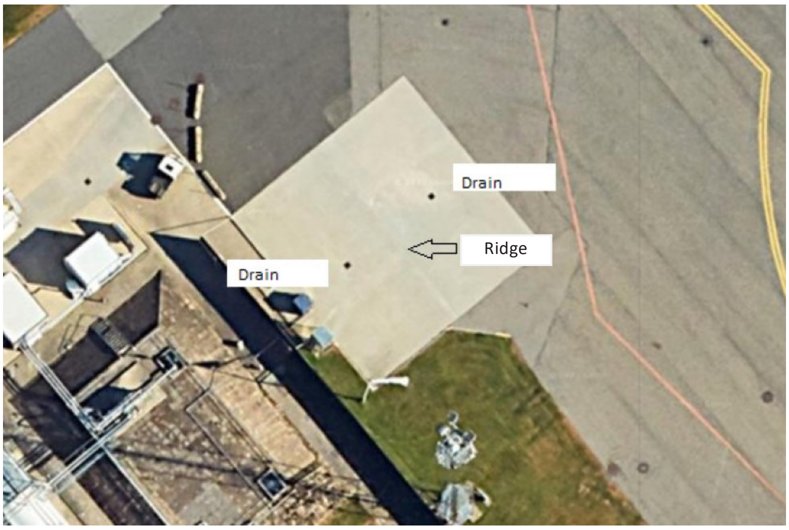


*Figure 6: aerial view of the refuelling area (source: Google Maps, annotations BEA)*

The steepest slope was measured at the position marked 1 in **Figure 7** and was 2.6°.


*Figure 7: measurements taken in the refuelling area of Aalborg airport (source: BEA)*

## 2.5 Persons on board experience and statements

### 2.5.1 Pilot

The 60-year-old pilot at the time of the accident held an aeroplane private pilot licence (PPL (A)) along with a SEP class rating. He held a valid class 2 medical certificate. He had logged around 785 flight hours including around 667 hours as pilot-in-command. He had logged around 25 flight hours as pilot-in-command in the three months prior to the occurrence, roughly half of these carried out in the previous seven days.

The pilot indicated that the landing gear extension-retraction system had been defective for around seven months before the accident flight. In this period, all the flights, including the accident flight, were carried out with the landing gear extended. He explained that he had asked a maintenance shop to carry out the repair in December 2023 and in April 2024 but that the cause of the failure had not been identified.

The pilot indicated that for the operation of his aeroplane, he used a French translation done by a pilot friend, of certain instructions of the flight manual, in particular cruise performance.

The pilot specified that he was not aware of the FAA's AD (see paragraph 2.3.3) concerning refuelling. He was also unaware that it was difficult to fill the tanks completely, especially on a non-horizontal surface. He stated that when he purchased the aeroplane from the previous owner, the placards mentioned in the airworthiness directive were not present. He added that he was not familiar with the Preflight Fuel System Quantity Check procedure, which was on a sheet in among the other aeroplane documents.

The pilot stated that the accident flight was the final leg of a cross-country flight in Scandinavia undertaken with the passenger. He explained that he calculated the fuel required for the flight based on an average consumption of 18 US gal/hour as displayed on the EDM. He stated that before the flight, they had replenished the tanks and checked the fuel level, first visually and then with a dipstick. He specified that they were aware that the aeroplane consumed a lot of oil, approximately 0.5 l/h, and that they therefore carried oil cans to top up the level during stops.

The pilot stated that he monitored the EDM indications and fuel gauges to manage fuel consumption during the flight. He explained that to determine the amount of fuel remaining, he privileged the EDM indications, as these were more accurate. He stated that he adjusted the engine rating and air-fuel mixture by observing the EDM. He specified that he measured the time using his watch and the hour meter.

During the return flight to Colmar, the pilot indicated that he had not planned to fly around the Strasbourg Regional Terminal Control. In his opinion, if they had been able to fly a direct route, it would have been fine. A few minutes' flight from Colmar aerodrome, he noticed a drop in oil pressure and a drop in engine power. According to him, there remained approximately 9 to 10 US gal of fuel at that time. He stated that he set the mixture control to full rich, set the propeller to full low pitch and extended the flaps to the first detent. Realising that an off-aerodrome landing was inevitable, he identified two suitable fields on his right-hand side, separated by a road. After turning, and on final, he realised that he would be landing in the field beyond the road. The pilot explained that he had not realised that the road was higher than the fields; the aeroplane struck it on short final.

#### 2.5.2 Passenger

The 64-year-old passenger held an aeroplane private pilot licence (PPL (A)) along with a SEP class rating, a night flight rating and an instructor rating (FI-(A)). He held a valid class 2 medical certificate. He had logged around 2,035 flight hours of which around 1,900 hours as pilot-in-command and around 1,500 hours as instructor. He had flown around 19 hours in the 3 months prior to the accident.

The passenger stated that he did not have much Cessna 210 experience and had only flown on this aeroplane with the pilot of N5767J.

He explained that during the cross-country flight in Scandinavia, they had completed five legs prior to the accident leg. The longest leg had lasted approximately three hours. The cross-country flight was undertaken with knowledge of the problem on the landing gear. He stated that fuel consumption with the landing gear retracted in cruise was approximately 18 US gal/hour at a speed of approximately 160 kt. He and the pilot noticed that with the landing gear extended, fuel consumption was the same at a cruise speed of approximately 135 kt. For the cross-country flight, they therefore estimated the fuel required based on a consumption rate of 18 US gal/hour and a cruise speed of approximately 135 kt. For the return flight, he believed that the endurance was sufficient and estimated it at 4 hours 30 minutes, taking into account a 30-minute final reserve fuel. He indicated that there was a westerly wind (from 220 to 230) which caused them to drift, but without giving rise to any major difficulty.

He specified that they were constantly monitoring the oil pressure because the aeroplane was consuming a lot of oil.

## 2.6 Meteorological information

The Wintem chart forecast a mean wind from 235° of 10 kt at FL 050 on the flight route.

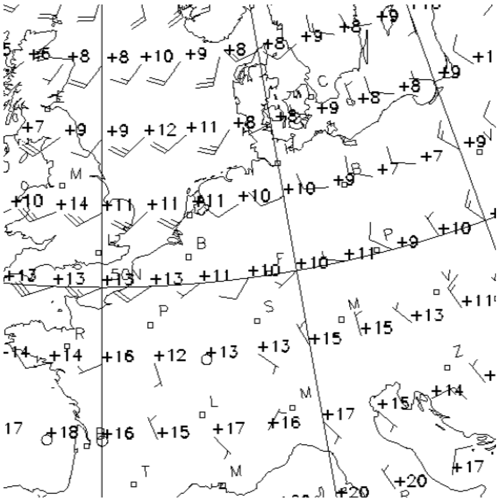

*Figure 8: excerpt from Euroc Wintem chart on 25 July 2024 at 12:00 UTC for FL 050 (source: Météo-France)*

The 17:30 automatic METAR for Colmar aerodrome indicated:

- mean wind from 070° varying between 030° and 100°, 4 kt;
- CAVOK;
- temperature 26°C, dew point temperature 13°C;
- QNH 1013.

## 2.7 Carrying and management of fuel for a cross-country flight

### 2.7.1 Applicable rules and good practices

The applicable rules for carrying fuel, for a VFR flight in the scope of a non-commercial operation on an other-then-complex motor-powered aeroplane are those in part NCO (Non Commercial Operations), Annex VII of the European regulation known as “AIR OPS”. For this type of flight, an alternate airport at destination is not required.

It is specified in NCO.OP.125 that, “*The pilot-in-command shall ensure that the quantity of fuel/energy and oil that is carried on board is sufficient, taking into account the meteorological conditions, any element affecting the performance of the aircraft, any delays that are expected in flight, and any contingencies that may reasonably be expected to affect the flight*.”

The probability of the pilot encountering a contingency that will affect the flight increases with the duration of the flight.

It is also specified that, "*The pilot-in-command shall plan a quantity of fuel/energy to be protected as final reserve fuel/energy to ensure a safe landing*." A safe landing is defined as *"a landing at an adequate aerodrome or operating site with no less than the final reserve fuel"*. The choice of the amount of fuel for the final reserve remains at the discretion of the pilot-in-command, who must carry out a risk analysis to determine it. A final reserve equivalent to at least 30 minutes for VFR cross-country flights by day is required (Acceptable Means of Compliance AMC1 NCO.OP.125 point b).

With respect to in-flight fuel management, the pilot-in-command must monitor the amount of remaining fuel to ensure that it is sufficient for a safe landing (NCO.OP.185). "*The pilot-in-command [...] shall advise air traffic control (ATC) of a 'minimum fuel/energy' state by declaring 'MINIMUM FUEL' when the pilot-in-command has [...] calculated that any [...] delays, may result in landing with less than the planned final reserve fuel/energy. [...] The pilot-in-command [...] shall declare a situation of 'fuel/energy emergency' by broadcasting 'MAYDAY MAYDAY MAYDAY FUEL' when the usable fuel/energy estimated to be available upon landing at the nearest aerodrome or operating site where a safe landing can be made is less than the planned final reserve fuel/energy*."

Several documents have been published concerning fuel load rules and the risk associated with inadequate fuel management.

In 2023, the DSAC published a document covering the regulations concerning the fuel load. The risk related to inadequate fuel management is mentioned in the BEA's 2021 light aeroplane thematic review.

The FFA, in a Practical Rules document concerning Fuel Estimates published in December 2022, listed six points for fuel management:

1. analyse the fuel boxes in the logbook before departure;
2. have a good understanding of your aircraft's characteristics;
3. prepare a fuel estimate in accordance with regulations (PART.NCO.OP.125), taking into account a taxiing and climb allowance, leg consumption calculated on the basis of a specific ground speed, unforeseen circumstances that may increase flight time, an arrival allowance and the regulatory final reserve;
4. carefully check and manage fuel before and during the flight. To do this, it is essential to measure time with a watch;
5. carefully carry out the walk-around inspection;
6. use the correct phraseology in the event of a problem.

### 2.7.2 Carrying and management of fuel for accident flight

The pilot's navigation logs used for the various legs of his cross-country flight showed that he calculated the fuel required for each leg, taking into account a final reserve of 30 minutes and the fuel consumption for the leg.

Fuel consumption per leg was calculated based on an airspeed of 135 kt and a fuel consumption of 18 US gal/hour. This speed was adjusted according to the wind forecast for the route. The logs did not indicate any fuel allowance for taxiing or for joining the circuit at the destination aerodrome.

The pilot had considered that he had replenished the aeroplane's fuel tanks, i.e. added 90 US gal, with 89 US gal which were usable including the 9 US gal of the final reserve. He entered the value of 90 US gal on the EDM before the flight.

#### 2.7.3 Engine data display

The EDM computer displays the fuel flow, the amount of fuel used and the remaining fuel. The fuel used calculation is based on the fuel flow and the remaining fuel is calculated by subtracting the fuel used from the total amount of fuel before start-up. This last value must be entered by the pilot.

The EDM records the main engine parameters every six seconds. The recorded data shows that the engine had operated for approximately 4 hours and 30 minutes in the occurrence flight. Taxiing and engine tests before take-off lasted approximately 15 minutes and used approximately 0.7 US gal. The flight time between take-off and the off-aerodrome landing was approximately 4 hours and 15 minutes. After take-off, the average consumption recorded by the EDM was approximately 19.3 US gal/hour, instead of the 18 US gal/hour estimated by the pilot. In cruise, the average engine speed was 2,580 revolutions per minute (rpm) and the average manifold pressure was approximately 25.7 inches of mercury[6].

The data recorded by the EDM showed that the amount of fuel used during the accident flight was 81.9 US gal. Thus, taking into account the unusable fuel (1 US gal), the amount of fuel in the fuel tanks after refuelling was around 83 US gal.

The EDM indicated that there was 8.1 US gal of fuel left. The value was displayed in red because it was below the value set as the low-fuel limit of 10 US gal. The sum of the two values (fuel used and remaining fuel) confirmed that the pilot had entered a total fuel quantity of 90 US gal in the EDM before departure.

At 17:43:35, the fuel flow rate dropped sharply in less than six seconds, from approximately 21 US gal/h to 1 US gal/h. This decrease coincided with a decrease in engine speed.

The engine oil pressure parameter indicated a decrease throughout the flight until it reached a value lower than that specified by the engine manufacturer (4 PSI instead of a minimum of 10 PSI).

#### 2.7.4 Estimation of fuel required for accident flight

For the occurrence flight:

- the distance between Aalborg airport and Colmar aerodrome is 547 NM;
- the forecast mean wind for the route was from 235 of 10 kt;
- the planned route was 186.

[6] Inches of mercury, abbreviated as inHg, is a unit of pressure. 1 inHg = 3,386.389 Pa.

An indicated airspeed (IAS) of 135 kt:

- taking the actual wind speed into account, gives a ground speed of 129 kt;
- a forecast flight time at this ground speed of 4 hours 15 minutes.

According to the flight manual:

- for a weight of 3,400 lb (approximately 1,540 kg), the fuel used from take-off to 5,000 ft at the best rate of climb, including the engine warm-up time, is 4 US gal at a standard temperature with an engine rating of 2,700 rpm and an IAS of 102 kt;
- in cruise, the pilot must select a manifold pressure of between 15 and 25 inHg and an engine speed of between 2,200 and 2,550 rpm. The combination of these two parameters must not lead to more than 75% brake horsepower;
- at 5,000 ft, with the normal lean mixture, an engine speed of 2,500 rpm and a manifold pressure of 24 inHg, power is 74% and the fuel used is 15.6 US gal/h;
- the holding speed is not defined, but the fuel used in cruise at 2,500 ft, for 2,200 rpm and a manifold pressure of 19 inHg, is 9.2 US gal/h.

Based on a taxiing allowance of 0.7 US gal and taking a fuel consumption of 15.6 US gal/h in cruise and 9.2 US gal/h for holding and joining the circuit, the quantity of fuel required for the flight was 76.6 US gal, which is less than the quantity used of 81.9 US gal (see paragraph 2.3.1):

| | |
|---|---|
| Allowance for taxiing before take-off and after landing | 14 US gal |
| Take-off and climb | 4 US gal |
| Cruise[7] (4 h 15 min) | 65 US gal |
| Arrival (approach and runway circuit: 10 min) | 1.6 US gal |
| Final reserve (30 min at holding speed at 1,500 ft) | 4.6 US gal |
| **Fuel required** | **76.6 US gal** |

This difference in the fuel quantity, as well as the difference between the fuel used recorded by the EDM and that estimated based on the flight manual, can be explained, in particular, by the pilot selecting a power setting leading to excess fuel consumption. It should also be noted that the power setting to be selected by the pilot is not included in the cruise performance table in the flight manual. The engine rating and manifold pressure values during the flight were higher than the highest values (cruise 81% brake horsepower) mentioned in the cruise performance tables of the flight manual.

[7] The flight time takes into account the distance already covered in climb.

# 3 CONCLUSIONS

*The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.*

## Scenario

Due to a non-identified technical problem, the pilot had been operating the aeroplane with the landing gear extended and locked for numerous flights.

Based on the fuel load and consumption estimations for the flight, the pilot considered that he needed a full fuel load. However, he did not have knowledge of the refuelling specificities of the aeroplane or the airworthiness directive issued by the FAA concerning this subject. He refuelled on a non-horizontal surface which meant that the fuel load was 6 US gal less than the maximum usable quantity (89 US gal) in the fuel tanks. The pilot then entered the erroneous value of 90 US gal in the EDM data display. Before the flight, the fuel load was thus 7 US gal less than what the pilot thought.

In cruise, the pilot's power selection led to an average fuel consumption of 1 US gal/h more than what he had planned. This difference led to an overconsumption of around 5.5 US gal during the flight. Relying solely on the fuel indication displayed on the EDM, which was erroneous as based on the fuel quantity entered on departure, the pilot and passenger did not detect the excessive fuel consumption nor the low fuel level. Their attention was focused on monitoring the oil pressure which had been continuously decreasing until it passed under the minimum value defined by the manufacturer at the end of the flight (no link was established with the loss of power, see paragraph 2.3.1). The pilot then notified the controller of an oil problem. About two minutes later, the fuel system unprimed and the engine lost power. The pilot had to carry out a forced landing. On short final, the aeroplane struck vegetation and then a road before overturning.

## Contributing factors

The following factors may have contributed to the fuel exhaustion:

- an inappropriate selection in cruise, of the air-fuel mixture (excessive enrichment) and engine speed, which led to them flying with excessive power and consequently excessive fuel consumption, not detected by the pilot or passenger;
- fuel management based solely on the amount of remaining fuel displayed on the EDM, which was an incorrect value given the difference between the amount of fuel in the tanks and the value entered on the EDM;
- attention possibly focused on monitoring the oil pressure, to the detriment of monitoring the fuel level;
- the pilot not taking into account, because he had no knowledge of, an airworthiness directive issued by the FAA concerning the refuelling specificities of the aeroplane.

Note (see paragraph 2.7.1): inadequate fuel management is a risk mentioned for example in the BEA's 2021 light aeroplane thematic review. As for the FFA, in December 2022, it published a Practical Rules document concerning Fuel Estimates, listing six points to mitigate this risk.

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