BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

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SAFETY INVESTIGATION REPORT

Accident to the BELL 47G-2 registered F-GANY on Tuesday 2 May 2023 at Thouars-sur-Garonne

Time	Around 14:00[1]
Operator	Giragri17
Type of flight	Spraying
Persons on board	Pilot
Consequences and damage	Helicopter damaged
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 supply failure, forced landing

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements.

In the scope of work to whiten polytunnels, the pilot took off for a first rotation of around 15 min. He landed and then the task specialist[2], with the rotor turning, topped up the helicopter with fuel (approximately 20 l) and whitening product.

After a flight time of around 20 min, the engine shut down as the helicopter was flying over a polytunnel. The pilot continued straight ahead towards a ploughed field next to the polytunnel and carried out a sliding landing. The ground was soft and the skids of the helicopter sunk into the soil. The pilot then pulled on the cyclic pitch stick to prevent the helicopter from turning over. The latter bounced three or four times before coming to a halt.

2 ADDITIONAL INFORMATION

2.1 Meteorological information

Météo-France estimated that the meteorological conditions on the accident site were wind between 10° and 50° of 4 to 6 kt, with gusts up to 11 to 13 kt, visibility greater than 10 km, clear sky, temperature 20°C, dew point temperature 8°C, QNH 1021.

[1] Except where otherwise indicated, the times in this report are given in local time.
[2] The task specialist's main duties are to convey the helicopter by road to the job site and to ensure that it is replenished with oil, fuel and spraying products.

2.2 Pilot information

The 56-year-old pilot held a CPL(H) licence with a Bell 47 rating. He had logged 638 flight hours including 35 hours in the previous three months all on type as pilot-in-command. He had followed training on whitening polytunnels at Giragri17.

2.3 Statements

2.3.1 Pilot's statement

The pilot indicated that while refuelling, the quantity of fuel was visually checked at the fuel tank using a diagram placed on the bubble sight (see paragraph 2.5) As the two fuel tanks are interconnected, they can be replenished by refuelling from one side only.

The day of the accident, after a discussion with the customer about the polytunnels to be whitened, the pilot topped up the fuel by adding just over 60 l in the left-hand tank and then waited for the level to balance between the two fuel tanks.

He specified that 60 l of fuel corresponded to a flight time of around 50 min. On F-GANY, he estimated the quantity of remaining fuel according to the elapsed flight time, on the basis of an hourly consumption of 70 l/h. He added that the fuel gauge was not easy to read and not very reliable. However, it indicated a "trend" that he compared with the chronometer and the estimated consumption.

As a general rule, he preferred taking off with 60 l of fuel. Every 35 min, he asked the task specialist to check the fuel level and to top it up to 60 l again. This method enabled him to keep a safety margin.

After starting up the engine, he hovered to check the parameters and then headed towards the polytunnels situated at around 6 km away. He whitened the first polytunnels, estimating the flight time at around 15 min. He deduced from this that there were 20 l of fuel left in each fuel tank, i.e. 40 l in total[3].

He asked the task specialist who in the meantime had taken up position close to the area to be treated, to top up the tanks to 60 l, i.e. add approximately 20 l of fuel. He emphasized that the task specialist had confirmed to him that visually, there were about 40 l left.

The pilot specified that the task specialist topped up the fuel in one of the fuel tanks with the rotor turning and that the latter informed him of the end of the operation. The task specialist also topped up the whitening product.

After the refuelling operation, the pilot took off and carried out two rotations overhead the polytunnels, i.e. a flight time of 20 min. During the third rotation, the engine shut down without any warning signs.

The pilot then decided to continue straight ahead towards an accessible field after the polytunnels.

[3] Based on a consumption of 70 l/h, a flight time of 15 minutes corresponds to the consumption of 17.5 litres of fuel.

He specified that he did not rely on the helicopter's low fuel level light as, according to him, it lit up prematurely. On landing, before topping up with fuel, the light was illuminated.

2.3.2 Task specialist's statement

The task specialist indicated that he joined Giragri17 in November 2019. He followed several training courses within the company in order to carry out the duties of task specialist. He specified that he had been given supplementary training to allow him to help the pilot with certain tasks such as lubrication, checking levels, bleeding and refuelling.

The task specialist arrived at the helicopter at around 11:30. He prepared it for the flights and then carried out the bleed and lubrication operations. The pilot had already refuelled. The task specialist indicated that he visually checked the fuel level, that he estimated as being around 60 l. He indicated that after the helicopter took off, he travelled by road to the landing area close to the polytunnels to be treated.

At the end of the first flight, the pilot asked him to add fuel in order to have 60 l and to fill the whitening product tanks again. He remembered having observed that there were 40 l left and that he therefore had to add 20 l.

He specified that the fuel pump flow rate was around 40 l/min and that in the absence of a totalizer, the quantity of fuel to be delivered is determined by the activation time of the pump nozzle. In the case of the refuelling at the end of the first flight, he was certain that he had activated the nozzle for around 30 s, and had filled the left-hand fuel tank. He added that he waited around one to two minutes before visually checking the fuel level in the left-hand tank and this level corresponded to just over 30 l, i.e. 60 l in total.

Around twenty minutes after taking off, the customer who was in radio contact with the pilot, informed the task specialist that the pilot had landed in a field, was out of fuel and that the helicopter was damaged.

The task specialist indicated that he had not observed any leak on the helicopter or marks or the concrete surface on which the helicopter had touched down. He specified that the concrete surface was exposed to the sun.

2.4 Helicopter information

F-GANY is a Bell 47G-2, built in 1956, equipped with a 200-hp Lycoming VO-435-A1 engine. Giragri17 purchased F-GANY in November 2003.

The operator specified that after bleeding the fuel system, it is essential to check that there are no leaks at the tank valves while waiting for the flow at the end of the bleed pipe to stop. Normally, pilots and mechanics are very familiar with this procedure as this operation is carried out at least twice a day.

2.5 Operator refuelling procedure

Helicopters are refuelled from a tank equipped with a pump, installed in a lorry. The pump has a 25 micron filter and a water absorber filter designed to stop refuelling in the event of clogging.

Between two helicopter rotations, the task specialist can refuel with the rotor turning in accordance with the company's Specialized Activities Manual. This procedure is authorized when the pilot-in-command has the controls and is alone on board the helicopter.

According to the task specialist, refuelling without a pump meter is carried out from the left-hand fuel tank by measuring the activation time of the pump nozzle. The operator underlined that this procedure in which the pump operating time is calculated in order to measure the quantity distributed are not company instructions.

The company specified that the instructions to check the refuelling are to visually check the level in the fuel tank.

The task specialist waits for the fuel tanks to balance before visually checking the level using a diagram placed on the bubble sight (see below).

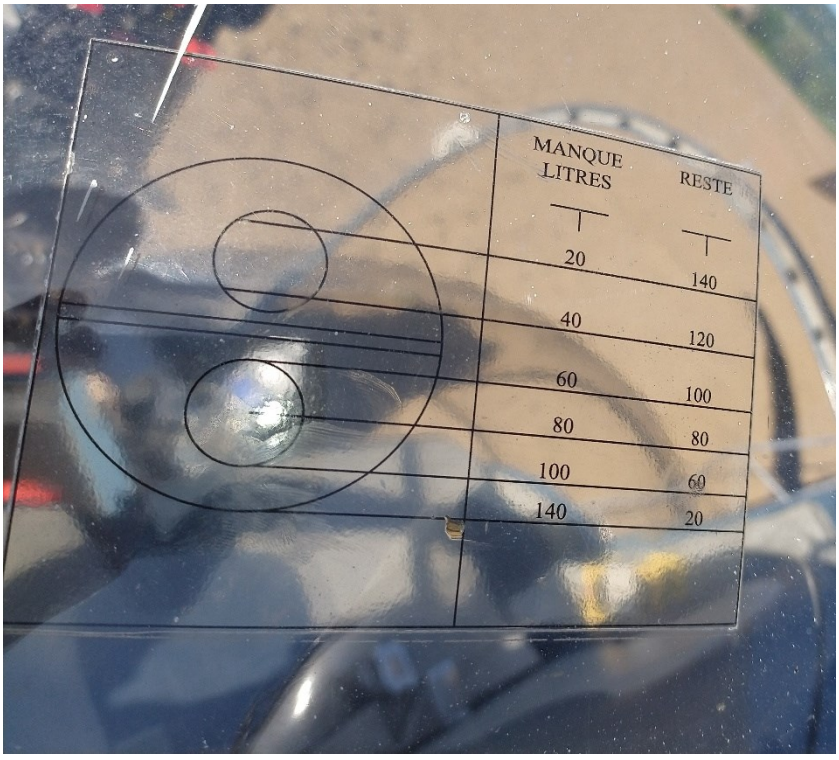


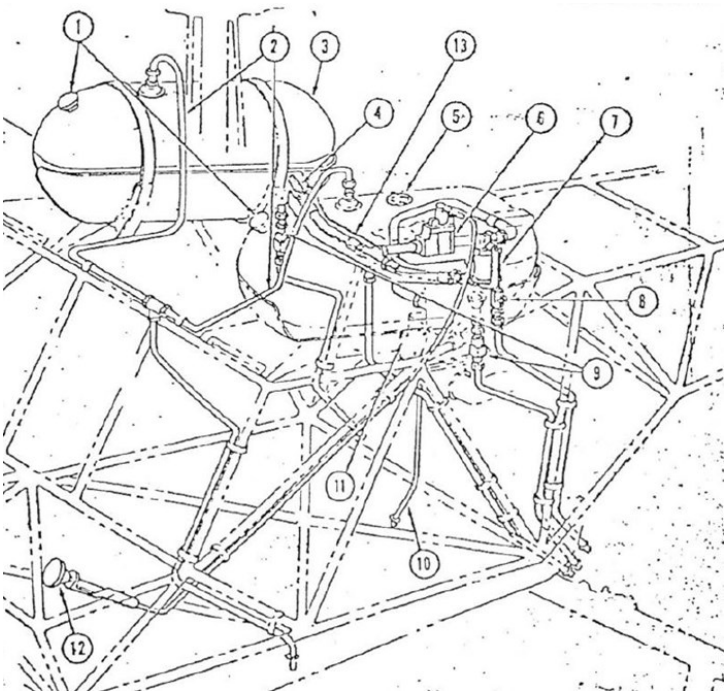
Figure 1: diagram placed on bubble sight of helicopter used as a reference to visually estimate the quantity of fuel by looking inside the left-hand fuel tank (source: BEA)

2.6 Examination of helicopter

During the BEA's examination of the helicopter, a re-enactment of the refuelling was carried out with the personnel present the day of the accident. During this, a large leak was observed at the bleed valve of the LH fuel tank although the valve was closed. The two fuel tank bleed valves were removed for additional examinations.

The operator specified that if a leak is observed after an action on the valve to carry out the fuel tank bleed, the flight must not be continued.

2.7 Bell 47 fuel system



1. Filler caps
2. Fuel tank vents
3. Fuel tanks
4. Filter inside fuel tank
5. Gauge
6. Fuel valve
7. Filter
8. Filter bleed
9. Fuel tank bleed
10. Air duct drain pipe
11. Carburettor (ref.)
12. Fuel valve control
13. Gutter

Figure 2: fuel system of Bell 47 (source: Bell 47G-2 flight manual, translation BEA)

The fuel tank bleed valve is located directly under the fuel tank. The fuel tank bleed system does not include a filter.

2.8 Examinations of bleed valves

The two valves were largely similar, however, their internal components to ensure the bleed function were different.

Tests were carried out in the shop to measure the flow rates when the two valves were completely open:

- the right-hand valve had a flow rate of around 4 l/min;
- the left-hand valve had a fuel flow rate of between 1 and 2 l/min.

With 60 litres of fuel when taking off and taking into account the average fuel consumption of F-GANY, the engine would have consumed around 23 l in the flight time of 20 min. After the accident, as the fuel tanks were dry, this supposes a loss of 37 l which is consistent with a leak of between 1 and 2 l/min. The total consumption during the flight would therefore have been 60 l.

2.8.1 Right-hand bleed valve

The operation of the valve is described in the diagram below.

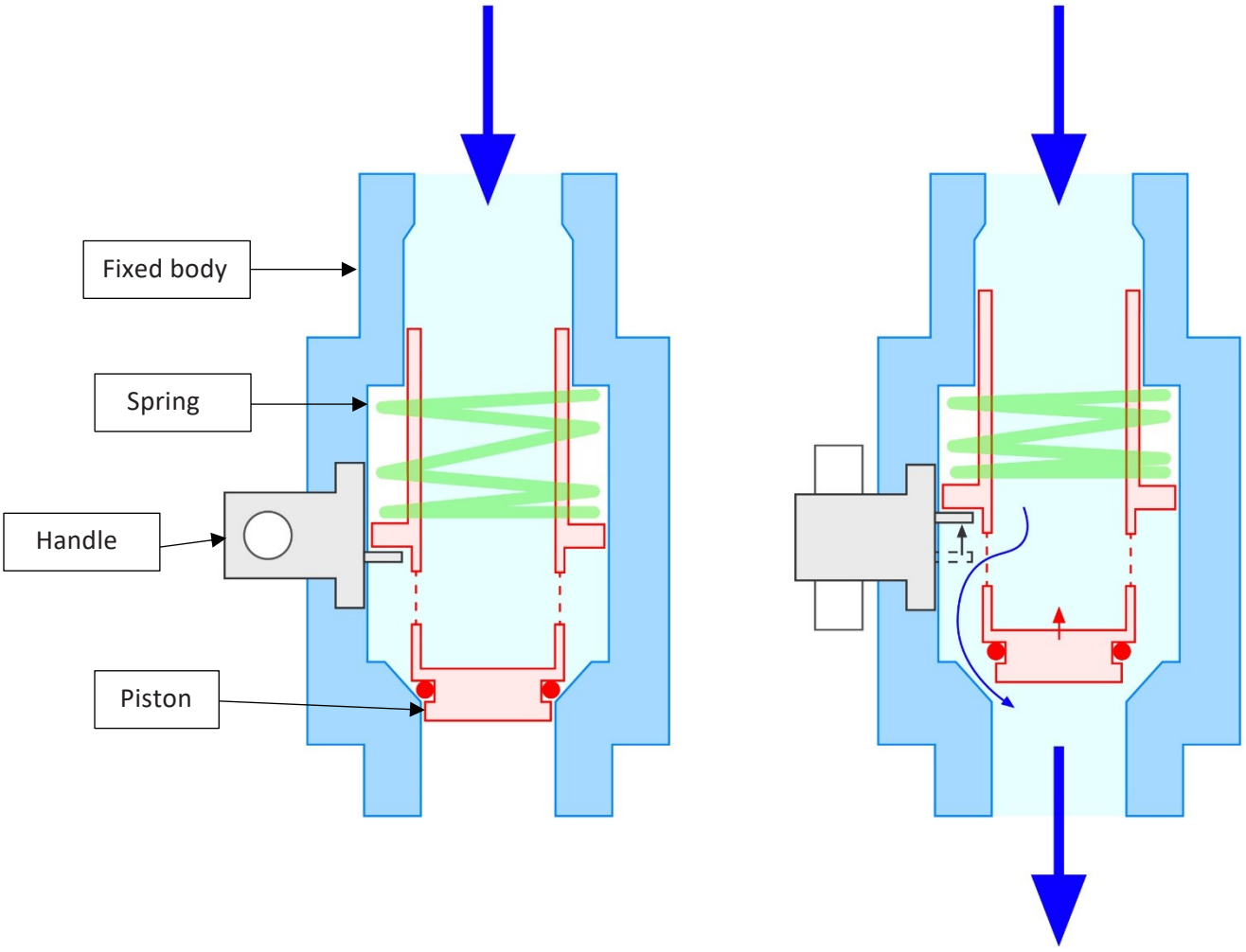


Figure 3: diagram showing operation of right-hand bleed valve (source: BEA)

In the closed position, the force applied by the spring combined with the weight of the fuel naturally holds the piston in contact with the fixed body, preventing any fuel flow.

When the handle is actioned to open the valve, this raises the piston by compressing the spring and allows the fuel to flow. The fuel runs through the two orifices and then the piston[4].

[4] The red dashes on the diagram represent the circular orifices present in the piston to let fuel through.

Figure 4: opened right-hand bleed valve (source: BEA)

The right-hand bleed valve was disassembled, it did not contain debris.

2.8.2 Left-hand bleed valve

Its operation is described in the diagram below.

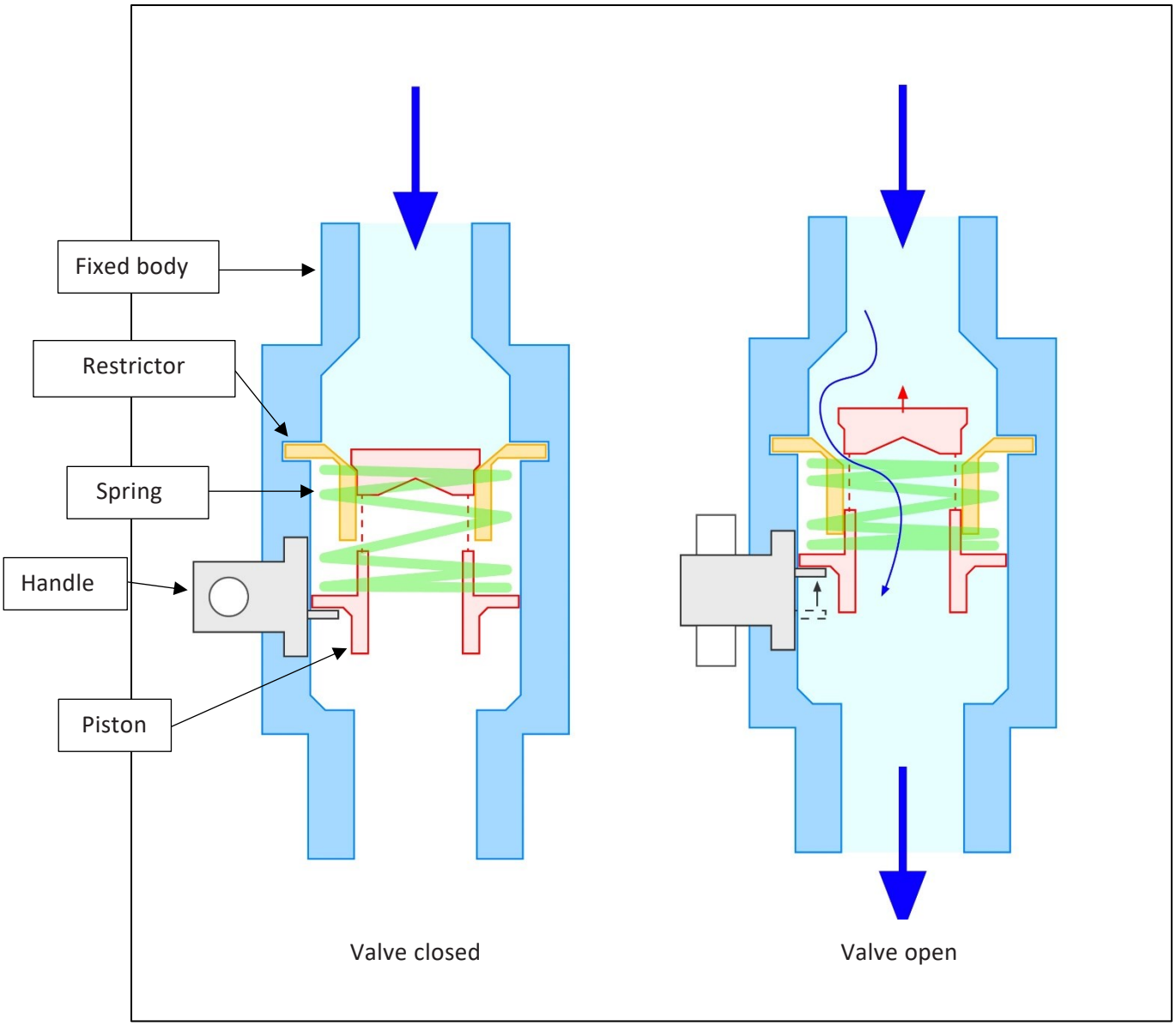


Figure 5: diagram showing operation of left-hand bleed valve (source: BEA)

The operation of the left-hand bleed valve is different to that of the right-hand bleed valve.

In the closed position, the force applied by the spring combined with the weight of the fuel holds the piston in contact with the fixed body, preventing fuel flow.

When the handle is actioned to open the valve, this raises the piston by compressing the spring and allows the fuel to flow through the piston orifices.

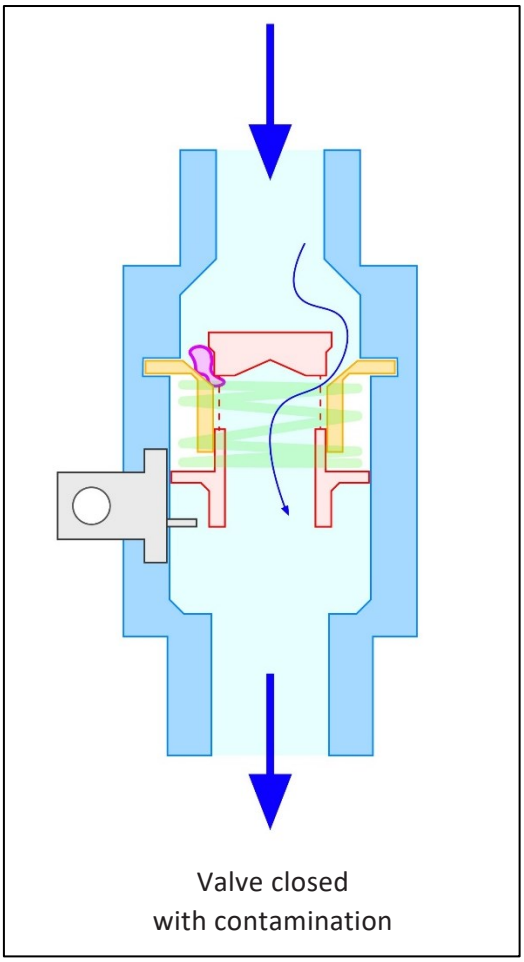


Figure 6: incomplete closure of valve with the presence of debris (source: BEA)

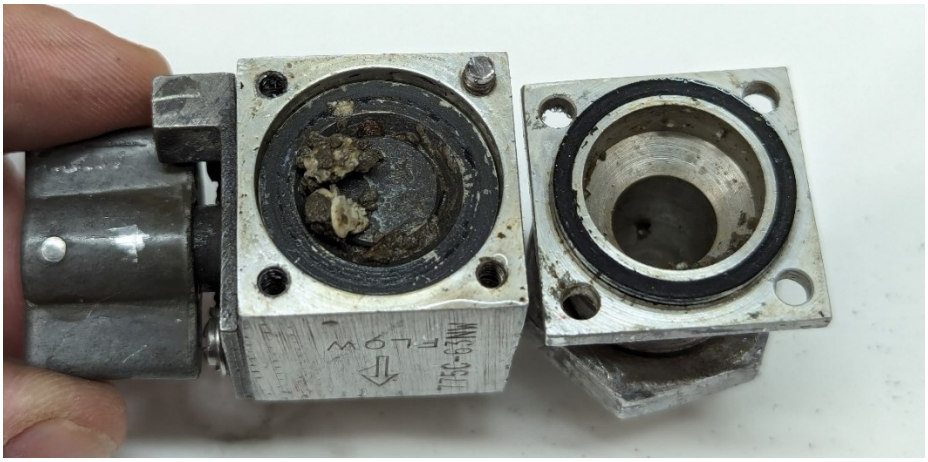


Figure 7: disassembled left-hand bleed valve (source: BEA)

The left-hand bleed valve was disassembled, it contained several pieces of debris. On closing the valve, the presence of debris caught between the restrictor and the piston may then prevent the piston from being correctly repositioned. In this case, the fuel can then continue to flow at a rate which will vary according to the size and position of the debris. This observation is consistent with the fuel flow found the day on which the helicopter was examined.

3 CONCLUSIONS

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

Scenario

The pilot took off for a first rotation of around 15 min. The task specialist then added 20 l of fuel and whitening product, with the rotor turning, before the pilot took off again for another rotation.

After a flight time of around 20 min, the engine shut down and the pilot carried out a forced landing. The pilot and the task specialist observed that there was no fuel left in the tanks.

During the examination by the BEA after the accident, a large leak was observed on the left-hand bleed valve: impurities were found inside the bleed valve and may have kept the valve partially open. This leak was very probably present before the accident (see paragraph 2.8) and contributed to an excessive fuel consumption which was not detected by the pilot. The engine shutdown may then be explained by fuel exhaustion due to the depletion of the fuel tanks.

Safety lessons

Refuelling a helicopter with the rotor turning may introduce various impurities into the fuel tanks. In this context, during the various maintenance acts, it is particularly important to check that the fuel tank is clean in order to prevent any contamination, including the possible blocking of the bleed valve by debris.

The circumstances of this occurrence has similarities with the accident to F-GVIV on 31 July 2018. In the BEA report, the importance of cross checking all the information available concerning the quantity of fuel on board was emphasized. While physically checking the fuel level is a good way of estimating the fuel load, more often than not, it is not a way of precisely determining the total volume which can be biased by numerous factors. Both on the ground and in flight, regularly checking the fuel level indicator in the cockpit will allow the pilot to identify a possible inconsistency between the different readings as will taking into account the low fuel level indicator. Furthermore, in the same report, it was also mentioned that the use of a pump meter on the fuel pump when refuelling can facilitate, for the pilots and mechanics, determining the fuel quantity actually on board and the estimation of the consumption between two full fuel loads.

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