



Accident to the WACO - YMF5 registered F-GYMF

on 06 August 2021

at Yvoy-le-Marron (Loir-et-Cher)

⁽¹⁾ Except where
otherwise indicated,
times in this
report are local.

Time	Around 15:15 ⁽¹⁾
Operator	Émeraude Aviation
Type of flight	Ferry
Persons on board	Pilot
Consequences and damage	Pilot severely injured, aeroplane destroyed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in April 2022. As accurate as the translation may be, the original text in French is the work of reference.

Engine shut-down in cruise flight, forced landing, collision with trees then the ground

1 - HISTORY OF THE FLIGHT

Note: the following information is principally based on the pilot's statement.

The pilot took off from Dijon-Darois aerodrome (Côte-d'Or), where the annual overhaul of the aeroplane was conducted, for Blois-Le Breuil (Loir-et-Cher) to refuel. He then planned to take off for Dinard-Pleurtuit - Saint-Malo (Ille-et-Vilaine), where the aeroplane was based.

After around 85 minutes of flight, cruising at a height of around 1,000 ft over a forest, the engine shut down with no forewarning. The pilot did not identify any zone suitable for a forced landing ahead of him but remembered he had just passed near a clearing. He turned around to the left and identified the clearing. He carried out the actions for restarting the engine from memory: he pushed the mixture and power control levers, that of the carburettor heat system, checked the magnetos and operated the starter. Then he checked the "EMERGENCY ENGINE CHECKLIST" plate in front of him on the instrument panel. He realised that he had forgotten to check the tank selection. He interrupted the sequence to look outside. Estimating that he was at a height of 400 ft and too low to continue trying to restart the engine, he decided to focus on the flying for the landing. Aware that he had no margin in relation to the trees at the edge of the clearing, he made sure that he maintained the best glide speed.

The aeroplane struck the branches of the trees at the edge of the clearing. The pilot lost control of the path. The aeroplane came to a stop in the clearing, around 15 m from the forest.

2 - ADDITIONAL INFORMATION

2.1 Aeroplane information

2.1.1 General

The Waco YMF5 is a modernised version of the YMF, built between 1935 and 1939. It has a type certificate that was first issued by the Federal Aviation Administration (FAA) in 1986, on the basis of a Supplemental Type Certificate (STC) applied to the YMF's original type certificate. The type certificate for the YMF5 is validated by the European Aviation Safety Agency (EASA).

The YMF5 is a biplane with conventional landing gear, fitted with a Jacobs R-755B2 radial engine and a fixed-pitch propeller.

2.1.2 Fuel system

F-GYMF is equipped with a left-hand and a right-hand fuel tank, each with a capacity of 24.5 US gallons (92.7 l), of which 0.5 US gal (1.9 l) is not usable. They are located in the central section of the upper wing, above the front cockpit. The engine is gravity fed with fuel.

Each tank has a valve which is controlled by a pull-type control, located on each side of the cockpit, level with the pilot's knees. The visibility of this pull-type control, from a normal pilot position, is relatively reduced.

When the pull-type control is pushed in, the system is open. A plate on each side of the cockpit recalls this information, with the wording "RIGHT [LEFT] FUEL / 24 GAL. USABLE / PUSH ON – PULL OFF".



Source: BEA

Figure 1: left fuel pull-type control, in closed position

Each tank is equipped with a float-type sight gauge, positioned under the upper wing in the central section of the tank, visible from the cockpit. According to the maintenance manual of the YMF5, the reading of this gauge is reputed to be reliable in level flight. This is not the case on the ground, owing to the aeroplane's attitude. On this gauge, the yellow line corresponds to a quantity of 10 US gal.



Source: BEA

Figure 2: fuel level sight gauge

The YMF5 maintenance manual states that the tanks drain according to no specific logic: "You need not be alarmed if after filling the tanks completely, one tank appears to drain faster than the other does. This is normal and there is no set rule as to which tank will drain fastest under certain conditions. On some airplanes one tank will drain faster one day and the other the next day". This information is not included in the flight manual.

2.1.3 Procedures

According to the aeroplane's flight manual, the procedures stipulate that the fuel valves must be checked during the pre-flight inspection, before start-up and before take-off.

A checklist is displayed in the aeroplane's cockpit, in abbreviated form, on the left, above the engine control levers:



Source: BEA

Figure 3: checklist displayed in the cockpit of F-GYMF

A plate showing the emergency actions to perform in the event of an engine problem is positioned on the main panel of the cockpit.



Source: BEA

Figure 4: Emergency Engine Checklist plate on board F-GYMF

2.1.4 Maintenance

The aeroplane had recently passed the annual maintenance inspection. During this inspection, in addition to the recommended operations, the fuel gauge of the right-hand tank was replaced. During these operations, the technicians closed the fuel system of the left-hand tank using the cockpit selector in order to drain the right-hand tank without emptying the left-hand tank.

Following the maintenance, a functional check flight was performed by the workshop manager. This flight lasted around 20 minutes.

2.2 Examination of the wreckage

The engine rotated freely. The examination of the propeller showed that, at the time of impact, the engine had been running without power or had shut down.

The right-hand tank was found in good condition, with no cracks or visible leak marks. No sign of fuel was found in this tank or in the associated fuel system. The right-hand fuel valve control was found pushed in, corresponding to the open position.

The left-hand tank was under the aeroplane fuselage and was found in a highly damaged condition. Owing to the extent of this damage, it was not possible to estimate the quantity of fuel in this tank at the time of the accident. The left-hand fuel valve control was found pulled out, corresponding to the closed position. Although it slid freely over its full range of travel, significant force was required to move it.

Tests were conducted and confirmed correct operation of the tank valves.

No emergency locator transmitter was found in the wreckage despite the presence of a switch on the instrument panel.

2.3 Pilot's experience and statement

On the day of the accident, the 48-year-old pilot held a valid Airline Transport Pilot Licence - Aeroplanes (ATPL(A)), along with B777/787 and Single Engine Piston land (SEP land) ratings, and a microlight pilot licence. He had logged more than 15,000 flight hours, 1,482 hours of which on SEP(land) class aeroplanes. In the previous three months, he had flown 12 hours and 40 minutes on SEP(land) class aeroplanes.

He jointly owned F-GYMF since August 2019. On this aeroplane, he had logged almost 37 flight hours, five hours of which in the previous three months.

The pilot explained that when he purchased the aeroplane, the previous owners warned him of the risk related to the fuel system architecture and to the fuel selectors, and of the fact that the tanks never drained in the same sequence. They had tried to establish a logical sequence for using the tanks to fly with balanced tanks, but had not managed to achieve this. In doing so, they had twice experienced engine shut-down due to fuel exhaustion. For this reason, the pilot and the other co-owners of F-GYMF decided to always leave the fuel selectors in the open position. The pilot added that, consequently, he never handled the selectors. When he checked them, he did so visually only, without touching them.

Before departing from Dijon-Darois, he filled the two fuel tanks himself to the maximum level by adding 90 l.

He remembered having indeed checked the right-hand fuel selector, which was in front of him when he entered the aeroplane from the left side of the cockpit. This selector was located on the side on which the gauge had been replaced and, for this reason, he paid special attention to it. He added that he made a rapid visual check of the other selector once he was seated in the cockpit.

He explained that the check-lists of the SEP(land) class aeroplanes on which he flew were simple and similar and that he completed them from memory. He added that he had allowed a sufficient margin and that there was no time pressure at the time of departure from Dijon-Darois.

The meteorological conditions enabled him to head directly to Blois. Given the elements gathered on preparing the flight, he calculated that there would be a headwind of 40 kt at 2,000 ft. Consequently, he decided to fly at an approximate height of 1,000 ft. He estimated the ceiling at 2,200 ft in the accident zone.

Regarding the gauges of F-GYMF, he believed that the gauge indicator could not be seen when the tank was more than half full. For this reason, if he could not see the indicator, he considered that the fuel quantity was at more than 50% of the capacity.

During flights with F-GYMF, owing to the specific features of the aeroplane, the pilot stated that he carried out the equivalent of “*turn point*” actions almost every five minutes: these actions included checking the adjustment of the manifold pressure, which varied greatly on this aeroplane owing to the vibrations, checking the position of the mixture control lever was full forward, and checking the gauges.

He recalled that before the engine shut down, he estimated the right gauge at around 20% and the left had not been visible, which he interpreted as an indication of a tank that was at more than half of its capacity. He had not considered these indications to be abnormal given the flight time passed, his knowledge of the aeroplane and the specific features identified.

2.4 Other statements

2.4.1 Accident witness

One person located near the accident site saw the aircraft gliding with its propeller stopped. He stated that he heard the engine start up again and saw the propeller turning, but the engine backfired for about ten seconds and shut down. He did not see any smoke.

He ran to where the plane was headed. While running, he heard the sound of the collision with the ground but did not see it because of a line of trees. Arriving on the scene, he called the emergency services and assisted the pilot.

2.4.2 Former owner of F-GYMF

One of the former owners of F-GYMF reported experiencing an in-flight engine shut-down with this aeroplane due to fuel exhaustion in the open tank while flying with one tank closed and the other open. He recalled that when he opened the second tank, the engine restarted without difficulty.

He added that when he purchased F-GYMF, the aircraft had been equipped with a fixed Emergency Locator Transmitter (ELT) with little battery life remaining. He and the other co-owners then decided to replace this transmitter with a portable transmitter. The aircraft was sold with this portable transmitter to the current owners.

2.5 Meteorological information

The ceilings estimated by Météo-France on the path followed and at the time of the flight were between 2,000 and 5,000 ft. The estimated wind at these altitudes was southwesterly of 20 to 25 kt. The wind was as forecast.

2.6 Fuel consumption

The aeroplane pilot provided the following consumption figures for F-GYMF:

Power (x100 RPM ⁽³⁾)	Consumption (l/h)	Speed (kt)
19	56	100
21	60	105

He cruises at 1,900 RPM for his flights.

Estimates of fuel consumption for the flight made, based on the two consumption values above, taking into account the wind estimated for the leg by Météo-France, the distance and the flight time, give values of about 80 l, without taking into account the fuel necessary for start-up, taxiing and take-off.

2.7 Survival aspects

According to his statement, after the impact, the pilot was not in a state to notify the emergency services of the accident himself. It was the witness to the accident who raised the alarm upon arrival at the site. First aid personnel estimated the pilot's condition to be life-threatening.

The pilot was not in contact with the Flight Information Service (FIS). He could not report the failure and his decision to make an off-field landing. Therefore, he could not benefit from the assistance service.

The pilot had not activated the transponder⁽⁴⁾. He thought of activating it to display the distress code, but did not have the time.

Concerning the emergency locator transmitter, the pilot was unaware that there was no fixed ELT on board. He thought about activating it but postponed his action to carry it out shortly before landing. He subsequently forgot to do so.

No portable emergency locator transmitter⁽⁵⁾ was found on the aircraft. The fixed transmitter was not installed, although the switch on the instrument panel may have suggested otherwise.

⁽³⁾Revolutions Per Minute.

⁽⁴⁾Regulation (EU) No 923/2012 (known as SERA) stipulates that when an aircraft [with sufficient electrical power] carries a serviceable SSR transponder, the pilot shall operate the transponder at all times during flight (SERA.13001).
[Version in force on the day of the accident.](#)

⁽⁵⁾According to Regulation (EU) No 965/2012 (known as AIR OPS), carrying an emergency locator transmitter is mandatory (NCO. IDE.A.170).
[Version in force on the day of the accident.](#)

⁽⁶⁾ Source: [Observatoire de l'Économie et des Territoires du Loir-et-Cher](#), 2018 data for the commune of Yvoy-le-Marron.

The accident took place in Sologne, in a rural and wooded area that has a population density of about 15 inhabitants per km²⁽⁶⁾. The wreckage was lying in a field surrounded by forests and not visible from the nearest road more than 500 m away.

In the absence of a witness, it is possible to imagine that the deployment of the emergency services and the location of the accident site would have been considerably delayed and that the pilot's chances of survival would have been reduced.

2.8 Similar occurrences

The U.S. National Transportation Safety Board (NTSB) conducted an investigation into an engine shut-down that occurred on a Waco YMF-F5C on 02 July 2016, in Austin, Texas. The aeroplane crashed into a lake, and the engine and fuel systems could not be fully examined. The investigation was thus unable to determine the exact origins of the engine shut-down. However, the right tank fuel selector was found in the closed position and the left tank fuel selector was found in the open position. The investigation report did not rule out the possibility that the lever had been pulled after the accident while the pilot was being evacuated. A study of the flight history since the last refuelling concluded that it was possible that the aeroplane had been used only on the left tank and that it had run dry at the time of the accident, while the right tank contained fuel.

The NTSB was also informed of a similar event through an accident report written by the pilot that had occurred on 19 May 2016, in Des Moines, Iowa. In his report, the pilot indicated that the engine had shut down due to fuel exhaustion, linked to forgetting to open a fuel supply valve.

Waco, when consulted on these events, indicated that in both cases, maintenance action had been performed on the aircraft, which had involved closing the fuel systems. After maintenance, it is thought that the operator opened a single valve to check for any leaks and to perform an engine test.

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

The pilot was on a ferry flight from the aerodrome where the annual maintenance of the aircraft had been performed. During this inspection, in order to work on the right tank, the left-hand fuel tank selector had been closed.

The pilot performed the actions and check-lists during the preparation and during the flight from memory and did not sufficiently check the position of the left tank valve.

In flight, the engine shut down due to fuel exhaustion linked to fuel depletion in the right tank, while the left tank was full.

The pilot performed the actions to restart the engine from memory but forgot to check the position of the fuel valve controls. When he referred to the emergency plate, he realised this omission but felt that he did not have time to attempt a re-start given the height.

The pilot did not transmit a distress message, activate the emergency locator transmitter or display the emergency code on the transponder. The emergency services were alerted by a witness to the accident.

Contributing factors

The following factors may have contributed to the fuel failure that occurred:

- ❑ the focus, at the time of the pre-flight checks, on the fuel system of the right tank on which the maintenance action had been carried out, to the detriment of the opposite side;
- ❑ the habit of managing the fuel linked to the specific features of the aircraft, which consisted in never closing the fuel systems, which could have decreased vigilance, and the pilot's familiarity with regard to the items related to this fuel management in the actions and action checks during the pre-flight inspection, before start-up and before take-off;
- ❑ the performance of actions and check-lists from memory before start-up and before take-off, phases of the flight during which it is not essential to perform these actions and checks from memory.

The choice to fly at a relatively low height over an area not conducive to a forced landing may have contributed to the severity of the consequences of the engine shut-down.

Safety lessons

Deployment of emergency services

Not activating the transponder or contacting the flight information services could have had more serious consequences if there had been no witness to the accident to alert the emergency services. Contact with the flight information services and activation of the transponder generally contribute positively to the rapid response of assistance or rescue services.

In an emergency situation, delaying the activation of the emergency locator transmitter may result in forgetting to activate it. It may therefore be preferable to perform this action without delay.

Overflight altitude

The event illustrates the value of taking into account the consequences of a possible engine failure when choosing a cruising altitude. When the area overflown is not conducive to a forced landing, as is the case in a wooded region such as Sologne, it may be important to give priority to a higher altitude at the expense of other factors such as performance optimisation.