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SAFETY INVESTIGATION REPORT

Accident to the PIPER - PA30 registered N7977Y on 2 March 2021 at Courcelles-sur-Viosnes

Time	Around 16:40[1]
Operator	Private
Type of flight	Instruction
Persons on board	Pilot and instructor
Consequences and damage	Aeroplane damaged

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

Right engine shut-down in airport circuit, difficulty in holding level flight, forced landing in a field, in instruction

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the pilot's and instructor's statements as well as on radio-communication recordings.

The pilot, who owned the aeroplane, accompanied by an instructor, took off from Toussus-le-Noble airport for a flight bound for Pontoise.

After approximately 20 min of flight, the pilot contacted the Pontoise controller and indicated that the approach would be followed by an airport circuit and then a full stop landing for refuelling.

At the end of the approach, the pilot performed a touch-and-go and joined the left-hand downwind leg to land on runway 05. At the end of the downwind leg, the power of the right engine markedly decreased. The instructor took the controls and applied full power on both engines. After confirming the failure of the right engine, he shut down the engine and feathered the propeller. He then observed that the power output of the left engine was not sufficient to maintain level flight[2]. He explained that he then raised the landing gear and kept the flaps retracted[3]. He informed the controller that they were going to land in a field. Shortly before landing, he shut down the left engine and retracted the landing gear.

The instructor landed in a field and the aeroplane slid approximately 60 m before coming to a stop. The two occupants were unharmed and evacuated the aeroplane.

[1] Except where otherwise indicated, the times in this report are in local time.
[2] The instructor and pilot could not remember the engine rpm value.
[3] Given the dynamic situation, the statements made by the pilot and instructor do not allow the precise chronology of the extension and retraction of the landing gear to be determined.

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2 ADDITIONAL INFORMATION

2.1 Site and wreckage information

The aircraft came to a stop in a ploughed field, slightly to the left of the axis of runway 05 and approximately 1.7 NM from the threshold.

Figure 1: site of occurrence (source: BEA)

The aeroplane was lying on its belly with the flaps retracted. The lower section of the fuselage was damaged. Both blades of the left engine propeller were bent backwards. These distortions are compatible with a rotating propeller and little or no engine output when the aeroplane made contact with the ground.

Each wing was equipped with three tanks (main, auxiliary and wingtip tanks). The two wingtip tanks as well as the LH auxiliary tank were found empty. The two main tanks as well as the RH auxiliary tank contained fuel.

The two fuel selectors were found in the "OFF" position. The pilot and instructor indicated that they performed the flight with the two main tanks selected and that they set the selectors to the "OFF" position after landing.

When raising the aeroplane and removing the two engines, the following observations were made:

- the two fuel strainers contained fuel;
- fuel was found up to the two fuel servo injectors.

The various examinations carried out at the site were not able to identify the cause of the engine failures reported by the pilot and the instructor. However, a certain number of anomalies indicating a lack of rigour in maintenance operations were observed[4], without it being possible to establish a link with the occurrence nor determine from when these anomalies dated.

[4] Vent hose detached from oil system, screwdriver found in wing near a tank, crankcase nuts loose.

2.2 Engine examinations

2.2.1 Test bench tests

N7977Y is equipped with two Lycoming IO-320 C1A engines. Each of these injection engines delivering a power of 160 hp are equipped with manually activated turbochargers[5].

The engines were installed and tested on a test bench. During the tests on the right engine, the following anomalies were identified:

- the engine started with difficulty;
- the engine vibrated and the increase in engine speed was jerky;
- the maximum speed reached was 500 rpm lower than expected;
- during the decrease in speed, the engine stalled at around 1,300 rpm.

At the end of the test, the external temperature of cylinder No 3 was close to the ambient temperature, which is indicative of an abnormal operation. The injector nozzle of the cylinder was removed and found completely clogged.

During the tests on the left engine, it was found that the engine delivered the maximum power expected. However, when rapid, high amplitude increases were required, delays in engine response were observed, as well as the engine speed increasing in "steps". These symptoms were identified as being most likely the result of a fuel metering fault at the cylinder intakes.

The systems (FSI[6]) regulating the fuel flow to the cylinders of both engines were removed for further examination (see paragraph 2.2.3).

2.2.2 Injector nozzle of cylinder of right engine

An examination of the injector nozzle revealed a deposit of material blocking the fuel flow.

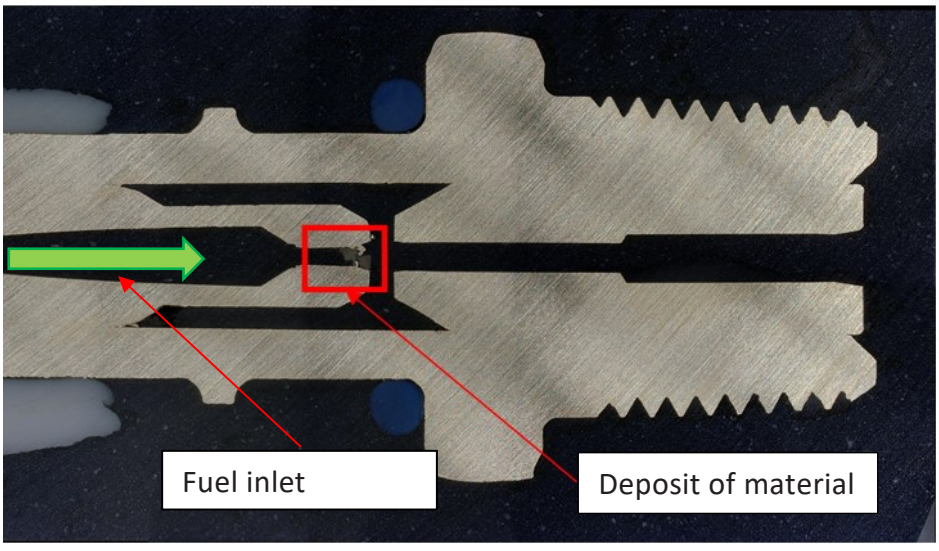

Figure 2: cross-sectional view of injector nozzle (source: BEA)

[5] In accordance with the limitations of these systems which cannot be used at low altitudes, the turbos were not activated at the time of the occurrence.

[6] Fuel Servo Injectors.

Damage to the injector nozzle was also observed in the area of the obstruction. This type of damage may be the result of cleaning or unclogging the injector nozzle with an unsuitable tool such as a metal rod.

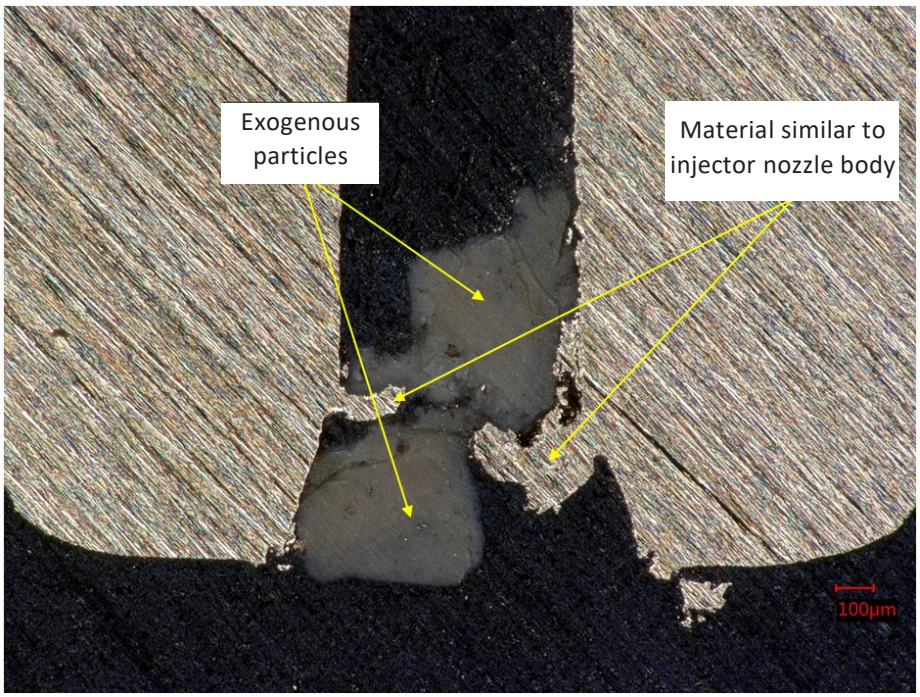

Figure 3: cross-sectional view of the clogged area (source: BEA)

No particular contamination was observed in the aeroplane's tanks or in the fuel samples taken.

2.2.3 Fuel Servo Injectors (FSI)

The fuel strainer of the right FSI was found bent. This distortion implies that the strainer will take a "bypass" position when installed in the FSI. The fuel is then no longer filtered. It should be noted that the strainer could be installed in the FSI without any particular difficulty despite this distortion and that it was difficult to detect that it took a bypass position.

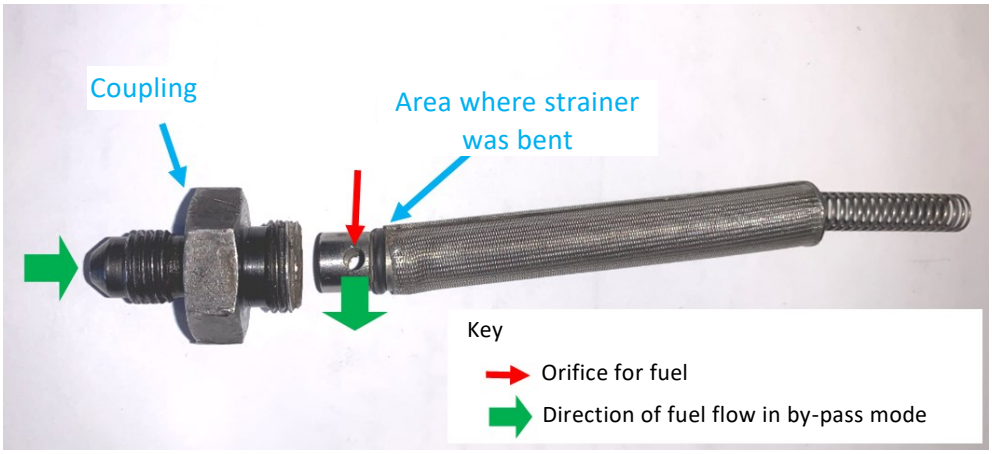

Figure 4: strainer of right FSI and its coupling (source: BEA)

Figure 5 below details the operation of a strainer in good condition, i.e. not bent.

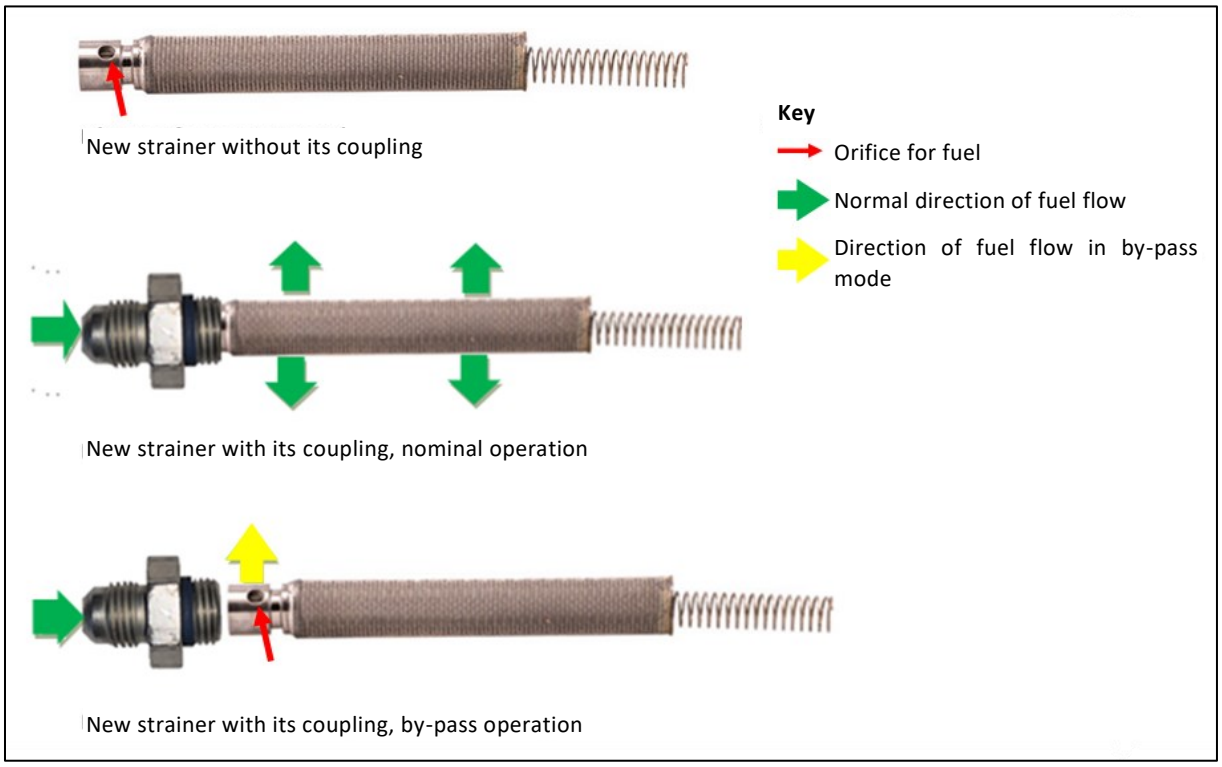

Figure 5: FSI strainer operating principle (source: BEA)

The two FSIs were tested on a test bench and then disassembled.

For the right FSI, fuel flow rates significantly higher than the maximum values stated in the manufacturer's documentation were observed on the test bench. This resulted in an air-fuel mixture which was too rich in the cylinders. For the left FSI, excessive fuel flows were also observed on the test bench, although the exceedances observed were lower than those observed for the right FSI.

During the disassembly of the two FSIs, several non-conformities affecting the fuel flow adjustments were observed (adjusting washers not compliant, adjusting nut position not within tolerances).

2.3 Aeroplane and maintenance information

The aeroplane was built in 1966 and had logged approximately 4,290 flight hours. The left and right engines had logged 410 h and 1,900 h respectively since their last overhaul.

A privately operated, U.S.-registered aeroplane is subject to Title 14 of the Code of Federal Regulations (CFR), Part 91, General operating and flight rules. As such, and in the absence of specific mandatory instructions from the manufacturer, maintenance could be limited to annual/100-hour inspections for the airframe and engines. The minimum programme for this inspection is described in Appendix D to the American regulation 14 CFR Part 43, maintenance, preventive maintenance, rebuilding, and alteration. These inspections are performed on an on-condition maintenance basis

and involve relatively basic actions (compression check[7], borescope inspection of cylinders, and various visual inspections). These inspections must be performed by a person holding a maintenance engineer licence under FAA regulations. Approval for return to service following an annual/100-hour inspection is then issued by a person holding an "Inspection Authorization" issued by the American civil aviation authority, the FAA. The owner is responsible for the airworthiness of his aeroplane.

The pilot purchased the aeroplane in August 2019; It was already registered N7977Y at this time. According to the documentation provided to the BEA, the last overhaul of the right engine was before 1991. The last overhaul performed on the left engine was in 2000, probably after a propeller strike. These engines had operated for approximately 400 h over the last 20 years.

In January 2021, the pilot asked a maintenance workshop to carry out the annual inspection. The programme for the latter was based on the annual inspection programme proposed in the aeroplane manufacturer's manual. This programme was very similar to that given in Appendix D to 14 CFR Part 43. During this inspection, the strainers of the FSIs were removed and cleaned. The abnormal distortion of the right strainer was not detected. The FSIs were not removed, as this operation is only performed as part of an engine overhaul. During this inspection, the workshop considered that it was not necessary to inspect and clean the injector nozzles[8].

At the end of this inspection, a staff member with an FAA-issued inspection authorization reported that he verified that all airworthiness directives applicable to the aeroplane had been complied with and that the tasks to be performed during the annual inspection had been completed. He inspected the aeroplane and signed the approval for return to service on 18 February 2021. This document also stated that a satisfactory run-up was carried out.

The pilot performed a two-hour cross-country flight on N7977Y on 21 February 2021, during which he did not observe any engine operating anomaly. The accident flight was the next flight.

2.4 Pilot and instructor information

The 58-year-old pilot held a Private Pilot Licence - Aeroplanes (PPL(A)) issued in 2010 as well as an MEP rating obtained in January 2020. He had logged approximately 990 flight hours, around 50 h of which in a twin-engine piston aeroplane.

The 35-year-old instructor held an Airline Transport Pilot Licence (ATPL(A)) issued in 2015 and an instructor rating (FI) issued in 2009, along with the IR and ME privileges. He had logged approximately 6,500 flight hours.

2.5 Meteorological information

The METAR issued by Pontoise airport at 16:30 indicated a wind from 060° of 3 kt and a CAVOK situation.

[7] The compression measurements carried out by the workshop during the last maintenance operation and those carried out by the BEA after the occurrence were in the tolerances defined by the manufacturer.

[8] This operation is not explicitly imposed in the aeroplane manufacturer's manual The non-compulsory Lycoming Service Instruction No. 1275C sets out precise instructions about cleaning the injector nozzles. This document indicates that this must be carried out during the engine's general overhaul or as engine conditions require.

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

During a training flight with an instructor, the pilot experienced a right engine failure in the downwind leg. The instructor then took the controls. After processing the failure of the right engine and making an input for full power on the other engine, he was unable to hold level flight. Unable to reach the runway, the instructor landed in a ploughed field.

The right engine shut-down was due to the clogging of the injector nozzle of cylinder No 3 by the build-up of contamination in the damaged area of the injector line. This contamination was able to reach the injector nozzle because the strainer of the system regulating the fuel flow to the cylinders (FSI) was no longer fulfilling its function due to distortion. This distortion, which does not cause any particular difficulty in removing or reinstalling the strainer, was not detected during the last annual inspection. The investigation was unable to determine when the strainer was distorted. The damage to the injector line probably occurred when the injector nozzle was cleaned with unsuitable tools. A precise date for this damage, which occurred before the last annual inspection, could not be determined.

The following factors may have contributed to it being impossible to hold level flight and reach the runway:

- A possible late retraction of the landing gear.
- A possible failure of the left engine which might not have provided full power when called upon. During the test bench tests, the requested marked, high-amplitude speed increases were erratic. This behaviour is possibly related to an incorrect FSI adjustment that resulted in an air-fuel mixture which was too rich in the cylinders. The investigation was unable to determine the reasons for the adjustment non-conformities observed on the FSI. Other than the strainer check, no work on the FSI was recorded in the documentation made available to the BEA. The FSI had probably not been overhauled since the last engine overhaul carried out more than 20 years before.

Safety lessons

Configuration management in event of engine failure on light twin-engine aeroplanes

The flight characteristics and performance of light twin-engine aeroplanes are substantially modified in the event of a failure of one of the two engines. In addition to the available power being reduced by half, the dissymmetric application of power will affect the control of the aircraft. In this context where the drag of the aeroplane is more important, the management of the landing gear and flaps is essential to maintain level flight.

Managing continuing airworthiness of a light aeroplane subject to American regulations

The U.S. maintenance framework for a light, privately operated aeroplane allows engine maintenance to be limited to an annual/100-hour inspection. Thus, it is possible that no thorough check of the engine will ever be carried out. In addition, when a succession of owners or people perform maintenance tasks, it is not always possible to track the tasks carried out.

The maintenance framework defined in the U.S. regulations should be read as the bare minimum to be applied, which implies that the owner should tailor the maintenance of his aeroplane to its history and conditions of use.

As continuing airworthiness managers, owners are responsible for suggesting additional maintenance operations to ensure that an aircraft remains airworthy, taking into account the aeroplane's age and history. To do this, they can rely on the expertise of the maintenance engineers.

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