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INVESTIGATION REPORT

Accident to the ROBIN - DR400- 120 registered F-GSBK

on 3 September 2018
at Bénodet (Finistère)

Time	Around 12:05[1]
Operator	Aéroclub de Quimper
Type of flight	Local
Persons on board	Pilot and two passengers
Consequences and damage	One passenger injured, aeroplane substantially damaged

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in May 2021. As accurate as the translation may be, the original text in French is the work of reference.

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

Failure of an engine cylinder en route, forced landing, overturn during landing run on beach

1 - HISTORY OF THE FLIGHT

Note: the following information is based on statements.

The pilot, accompanied by two passengers, took off from Quimper Pluguffan aerodrome (Finistère) for a local flight to the Glénan islands situated at around 17 NM south-south-east of the aerodrome. The pilot descended to a height of around 500 ft above the sea so that the passengers could take photos of the group of islands. He then wanted to gain altitude but his input on the power level had no effect. The engine started to vibrate, oil was splashed onto the canopy and smoke escaped from the engine cowling. The pilot could not find an area on the islands suitable for a forced landing. He turned back towards the mainland and made an emergency call. The residual engine power permitted the pilot to hold speed and level flight at an altitude of 500 ft. He configured the plane for an east-facing landing[2] on a beach. The engine shut down and the propeller locked before the turn east to align with the axis of the beach. The presence of a person on the beach made the pilot alter his path to the right and approach the edge of the water. On landing, the aeroplane turned over onto its back and came to a stop in the water.

[2] Northeasterly wind of 10 kt.

The passengers evacuated the aeroplane unaided.

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Source: Le Télégramme (newspaper) (Photo: DR)

Figure 1: Photo of F-GSBK at end of emergency landing

2 - ADDITIONAL INFORMATION

2.1 Pilot information

The pilot held a valid Private Pilot Licence (aeroplane) (PPL(A)) issued in September 2012. He had logged 132 flight hours, of which 3 hours in the last 3 months as captain and on type.

2.2 Examination of engine

The aeroplane is equipped with a four-cylinder Lycoming O-235-L2A engine providing 118 HP at a rating of 2,800 rpm. The engine is associated with a Sensenich fixed-pitch, two-blade, metal propeller.

2.2.1 General findings

The crankcase was perforated in line with cylinder No 4, on the rear left side of the engine. Cylinder No 4 had failed on all of the circumference of its steel barrel[(3)] in immediate proximity to its base plate still attached to the engine. This base plate had also failed radially. There was no top coat paint in line with this break and superficial corrosion was found on the surface. The outer surface of the three other cylinders also had superficial corrosion instead of paint.

The four engine cylinders correspond to the model specified by the manufacturer for this engine[(4)].

There were whitish residues where the cylinders were assembled on the crankcases in addition to the O-ring specified by Lycoming. The origin of the product which caused the residues was not identified.

[(3)] The cylinder is composed of two parts: the steel barrel fixed to the half crankcase and the aluminium alloy cylinder head screwed onto the steel barrel.

[(4)] https://www.lycoming.com/content/parts-catalog-o-235-l2a-l2c

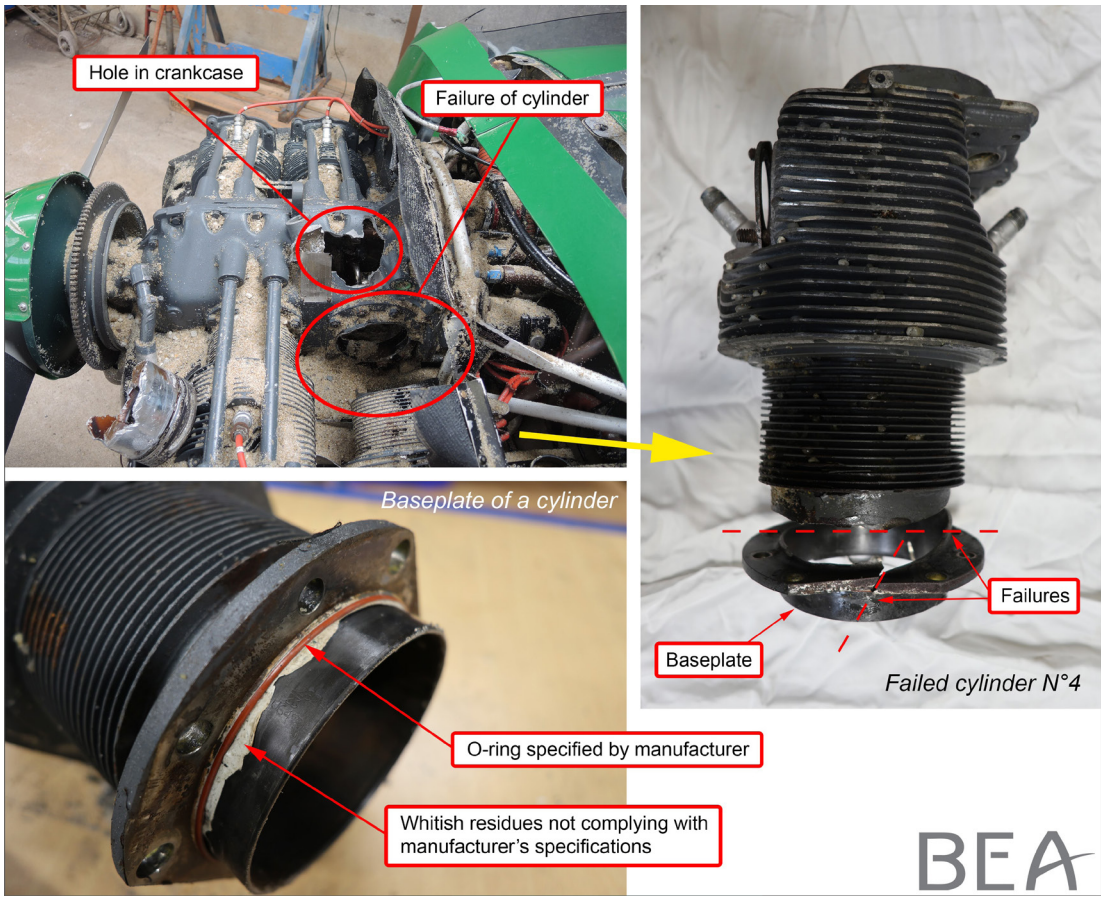

Figure 2: Photos of engine and cylinder No 4

The rod of cylinder No 4 was not found. There was a large amount of damage on its piston.

The disassembly of the engine did not reveal any sign of unusual lubrication which could explain the premature failure of the engine. There was no significant damage on the crankshaft and inside the cylinder. The separation of the "rod and piston" assembly of cylinder No 4 thus seemed to be the consequence of the failure of this cylinder.

2.2.2 Examination of cylinder No 4

The detailed examination of cylinder No 4 revealed that this failure was the result of a fatigue cracking phenomenon in the steel barrel of the cylinder. The fracture was damaged with peening over a large part of its face[(5)]. This advanced state of damage meant that it was not possible to identify the incipient crack site(s) or the exact dimension of the crack on the circumference of the cylinder. Nevertheless, the presence of indications of crack formation in at least two distinct areas of the fracture along with the peened and oxidized appearance of the face seem to indicate a cracking process which progressively developed over time, without it being possible to define when it started.

(5) During the cracking process, the pressure of the surfaces pressing against each other results in their superficial compression which can obliterate all or some of the crack formation indications.

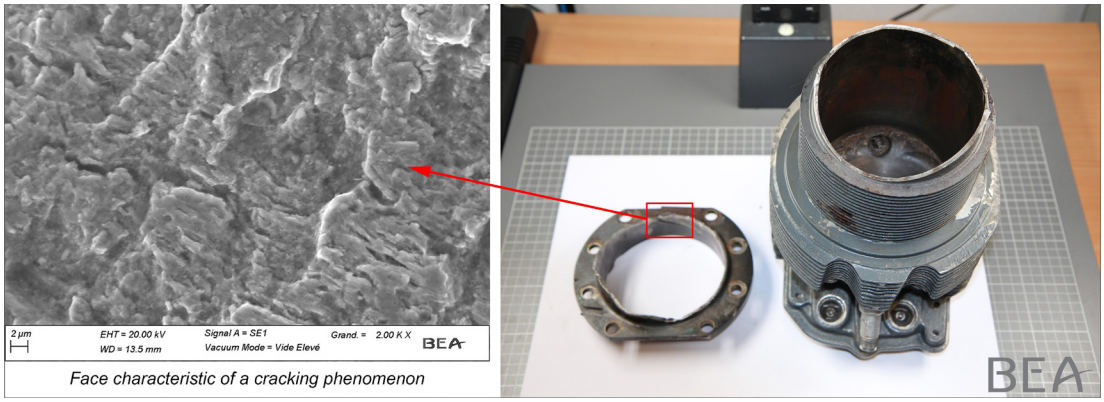

Figure 3: Examination of cylinder No 4

2.3 Maintenance of engine

The continuing airworthiness of F-GSBK was managed by Xénon Aviation, a Continuing Airworthiness Management Organisation (CAMO). The maintenance actions were carried out by the club's mechanic who held a Part 66 licence for this type of plane.

On 27 August 2018, the date of the last maintenance operation (50-hour inspection), the engine had logged 2,259 operating hours (a manufacturer's Service Bulletin specified an operating time of 2,400 hours between two overhauls).

2.3.1 Check of the static leak rate of the cylinders

The manufacturer recommends this check in the event of loss of power, increasing oil consumption, difficulties with starting the engine or when an anomaly is encountered. It is also recommended to check the engine at intervals of 100 flight hours or each year. The manufacturer's specifications regarding this check are described in Service Bulletin No 1191 revision A, dated 28 September 1998. The check must be carried out while the engine is hot, cylinder by cylinder. It consists of injecting compressed air through a spark plug hole at a fixed pressure of 80 psi with the piston held at "top dead centre".

The pressure must be applied using a specific device. The "upstream pressure" and the "downstream pressure" correspond respectively to the air supply pressure of 80 psi and the pressure measured downstream of the device which permits the leak rate to be measured. The following criteria are used to determine the maintenance actions to be carried out:

Downstream pressure ≥ 70 psi	The cylinder is considered satisfactory.
60 psi < Downstream pressure < 65 psi	Leak rate measurements must be carried out at 100-hour intervals.
Downstream pressure < 60 psi	Removal and overhaul of cylinder.

The examination of the maintenance data between 26 June 2017 and 27 August 2018, date of the last inspection carried out (50 hours) before the accident flight, gives the following leak rate values:

- For the three 100-hour inspections between 24 July 2017 and 27 October 2017: the cylinder leak rate values were more than or equal to 70 psi (except for the leak rate measurement of cylinder No 1 on 27 October 2017 which was equal to 60 psi).
- For the 100-hour inspections on 5 February 2018 and 30 May 2018: the cylinder leak rate values indicated were less than or equal to 38 psi.
- For the 100-hour inspections on 11 July 2018 and 9 August 2018: the cylinder leak rates were not indicated.

According to the information provided by the CAMO, the leak rate values of less than 38 psi were due to the method employed and tool used. Furthermore, similar values were found in the maintenance data of other planes of the club. The ordering of and use of suitable equipment by the club, at the CAMO's request, subsequently permitted valid and consistent leak rate values to be obtained for the club planes.

2.3.2 Salt-laden and tropical environment

The plane's maintenance program established by the manufacturer specifies an annual search for corrosion when the plane is used in a salt-laden and/or tropical environment. No maintenance data indicated such a search being carried out for F-GSBK.

2.4 Similar occurrences

Thirty-four similar occurrences between November 1995 and November 2003 with the same type of engine and the same damage mode as that on cylinder No 4 of the F-GSBK engine have been identified. Several of these occurrences have been the subject of a BEA safety investigation. The cylinder models concerned were different to the cylinder model of the F-GSBK engine. In six occurrences, incipient cracks occurred in immediate proximity to the base plate, in the outer surface, contributed to by corrosion. For two of these six occurrences, the leak rate values recorded during the 100-hour inspection which preceded the occurrence had revealed no anomaly.

Following these occurrences, the DGAC issued an airworthiness directive in 1998 imposing regular inspections of the cylinder barrels. This airworthiness directive was not adopted by EASA. For its part, Lycoming published a Service Bulletin (No 1504) which specified the replacement of the cylinders of the O-235 series engines, with cylinders with better resistance to corrosion. All the new cylinders which Lycoming has delivered to Europe since 2000 are this new model, including those on the engine of F-GSBK. The examination of the Lycoming database since 2000 only revealed one case, in 2005, of cracking in the barrel of a cylinder manufactured to have better resistance to corrosion. However, this crack was not linked to corrosion but to high stresses, the cause of which was unknown.

In 2009, EASA published a Safety Information Bulletin (SIB No 2009-24 dated 6 August 2009), based on a recommendation made by the AAIB after a safety investigation into a similar accident in 2006. In particular, this bulletin asked operators of aeroplanes equipped with O-235 series engines whose cylinders had not been replaced in accordance with the Lycoming service bulletin to check the cylinder barrels during scheduled maintenance.

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 local flight off the south coast of Brittany, one of the four engine cylinders failed while en route. This failure was the consequence of a fatigue cracking phenomenon in the steel barrel of the cylinder. The condition of the fracture seems to indicate that this process had started some time previously without, however, being able to date it. The only singularity found in line with this fracture was the presence of corrosion. The pilot managed to return to the coast with the residual engine power. The engine then shut down and the pilot landed on a beach. During the landing run, the aeroplane turned over onto its back and came to a stop in the water.

The absence of recorded leak rate measurements in the last two 100-hour maintenance inspections did not enable the possible detection, during inspections, of an anomaly on the cylinder which failed. In addition, the available maintenance data did not mention annual searches for corrosion on F-GSBK due to its operation in a salt-laden environment.

The safety investigation was not able to determine the contributing factors to the damage phenomenon which led to the complete failure of the cylinder in flight.