Serious incident to the De Havilland - DHC-6 Twin Otter Series - 300 registered **F-OCQZ** operated by Aircalin on Tuesday 4 May 2021 at Futuna Pointe Vélé (Wallis and Futuna islands)

Time	Around 11:10[1]
Type of flight	Freight commercial air transport
Persons on board	Captain (PF[2]) and co-pilot (PM)
Consequences and damage	None
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.	

Loss of engine power during final approach

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements. The aeroplane was not equipped with flight recorders.

F-OCQZ was carrying out a freight commercial air transport flight between Wallis-Hihifo and Futuna Pointe Vélé airports (Wallis and Futuna Islands). The flight was scheduled to last 53 min.

The aeroplane was light: the freight carried corresponded to a load of 120 kg. The fuel (873 kg) carried corresponded to three legs (outbound and return legs, with a possible diversion to Futuna). The remaining available load was more than one tonne (1,096 kg).

At the start of the descent, with the autopilot engaged in vertical speed mode, the aeroplane suddenly adopted a steep nose-up attitude. The PF disconnected the autopilot and pushed the stick to correct the aeroplane's attitude. He noticed that a substantial force was required to make this correction and realised that the elevator trim was at its nose-up limit.

The PF cut off the electric trim and continued the flight in manual mode.

As he was approaching the destination airport, given the weather conditions observed, he decided to make a visual approach to runway 25. As the AFIS agent had informed them that there was a north-westerly wind, the crew anticipated possible turbulence on final due to the wind passing over the island's terrain. The approach speed was increased by 10 kt.

[1] Except where otherwise indicated, the times in this report are given in Wallis and Futuna local time the day of the occurrence. Twelve hours should be subtracted to obtain Coordinated Universal Time (UTC).
[2] The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.

According to the crew, at 500 ft, the approach was stabilised.

At approximately 400 ft, the speed increased to 90 kt[3]. The PF moved the power levers to the idle position. The speed decreased and the PF returned the levers to the “final power” position. As the speed continued to decrease, the PF made repeated inputs on the power levers until the “full power” stop was reached. During this phase, the PF held the approach slope and aiming point. The successive inputs on the power levers up to the full power stop seemed to have no effect and the speed continued to decrease.

When the speed reached 62 kt, the PF made a nose-down input on the stick to maintain a margin in relation to the stall speed (around 56 kt). The aiming point shifted to the area located between the shoreline and the runway threshold. The speed increased to approximately 66 kt.

He flared over this area and used the ground effect to land on the runway.

The PF managed the landing run without any particular difficulty, using the power levers between the idle and reverse positions (beta range).

On the apron, the crew moved the RH engine (#2)[4] power lever to the forward limit and observed that this action had no effect.

2 ADDITIONAL INFORMATION

2.1 Scope of flight - Operation of Wallis-Futuna service

The Wallis-Futuna service is operated by Aircalin as part of a public service delegation contract to ensure territorial continuity. The availability of the service is one of the requirements of the contract, the objective being to have fewer than 3 % cancellations.

Two DHC-6 Twin Otter Series 300s, regional air transport aeroplanes built by De Havilland Aircraft of Canada Ltd fly the route. The DHC-6s are powered by two PT6A-27 turboprop engines manufactured by PRATT & WHITNEY Canada.

Aircalin operates these DHC-6s with a two-pilot crew. Six pilots (five captains and one co-pilot) are based at Wallis.

Aircalin is approved for the continuing airworthiness management of and maintaining both aeroplanes. At the Wallis site, eight people work in the production department, providing line and base maintenance for the two DHC-6s (see paragraph 2.7.2.2).

2.2 Meteorological information

2.2.1 General weather situation on the day of the occurrence

On 4 May 2021, Futuna Island was under the influence of a large, unstable zone of convective activity. There was a mostly light, northerly wind, with probable gust effects near convective clouds.

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[3] The VFE was 93 kt in the selected configuration (flaps 20°).

[4] The crew carried out this test on RH engine #2 because of previous malfunctions on this engine.

Between 10:00 and 12:00, the weather was characterised by an unstable, moist air mass in the low layers. The sky was very cloudy with a ceiling between 1,500 and 2,000 ft over Futuna Pointe Vélé airport. The medium to light north-westerly wind was about 16 kt at 11:10.

The readings made at Futuna Pointe Vélé airport indicated the following:

At 11:00, the wind, varying in direction, was of 2 kt. There were scattered clouds at 2,300 ft and broken clouds at 3,100 ft and 3,700 ft.

At 11:30, the wind from 300°, varying from 240° to 60°, was of 5 kt. There were scattered clouds at 1,000 ft and broken clouds at 2,400 and 3,500 ft.

2.2.2 Information available to crew

The crews did not have the measurements for Futuna airport due to the unavailability of certain parameters normally measured at Mount Mamati (a mountain near the airport). They had forecasts (long TAF) in the flight file.

From 06:00 on 4 May to 06:00 on 5 May, the forecast indicated wind from 060° of 10 kt and visibility greater than 10 km, with temporarily, from 09:00 to 18:00, visibility reduced to 1,400 m, rain showers, broken clouds at 900 ft, scattered cumulonimbus at 1,800 ft and scattered clouds at 2,500 ft.

The pilots had obtained the latest meteorological data from the AFIS before departure and at the start of the descent. The wind was reported as being from 250° of 10 kt, varying from 200° to 300°.

2.3 Operational aspects

2.3.1 Crew experience, report and statements

2.3.1.1 Captain

The 51-year-old captain held a CPL (A) licence issued in 2010 and a DHC-6 type rating. He was type instructor. He had logged around 10,000 flight hours including 6,200 hours as captain. He had totalled 4,500 flight hours on type including 4,350 hours as captain.

In his previous company where he also flew the DHC-6, he was responsible for training.

2.3.1.2 Co-pilot

The 53-year-old co-pilot held an ATPL (A) licence issued in 2005 and a DHC-6 type rating obtained in 2009. He had been a type instructor and examiner since 2010. He had logged approximately 9,000 flight hours including approximately 5,000 hours on type as captain.

He had worked for Aircalin since 2018 and was the Operations Manager for the DHC-6 fleet.

2.3.1.3 Air Safety Report (ASR) and statements

In addition to the elements indicated in the history of the flight (see paragraph 1), the pilots reported the following information concerning the management of the approach.

The captain indicated that the approaches to Futuna are often visual, most of the time to runway 07. Due to the island's topography, the wind passes over the island when it comes from the north. As the runway is adjacent to the terrain, there can be quite strong turbulence on arriving at Futuna.

On that day, runway 25 was in use. The ceiling was high, but rain was approaching the runway from the east. Both the downwind leg and Futuna Island remained clear, and a visual approach was possible. The crew were expecting some turbulence. The co-pilot indicated that they considered the following threats for the approach: the possibility of windshear and the approaching precipitation. They did not mention the engines.

For the landing weight that day (4,334 kg) and a flaps 20° configuration, the Vref was 71 kt. The calculated minimum Vapp was 76 kt (minimum correction of 5 kt applied to the Vref); the crew adopted an approach speed of between 80 and 85 kt, i.e. a correction of 9 to 14 kt.

The captain explained that, according to the procedures, reducing power to idle indicates that the approach is not stabilised and results in a go-around. However, in his opinion, a brief transition to idle is common practice on Twin Otters; the stabilisation floor at 500 ft seems very high to him for this type of aeroplane.

On the day of the event, after reducing the power to idle, he immediately moved the power levers back to a position compatible with a standard approach. He specified that at that point, he was no longer looking at the engine torque indications. In this case, the scan pattern is "outside, attitude, speed". He called out that the power was not increasing. He could not hear the engines - the aeroplane is usually noisy, but there was no noise and no feeling of a nose-up effect caused by the increase in power.

The PM reported that when the speed was at 68 kt, he saw the captain's corrective input and perceived a slightly louder noise on the LH side. He indicated that the speed was below 70 kt at a height of between roughly 150 and 100 ft, then it began to increase again. He did not look at the torque indications, his attention was focused on the speed. They had a rate of descent of approximately 400 ft/min, and according to him, the occurrence lasted around 20 s. This interval would therefore have been longer than the time necessary for the engine power to increase, which is around 4 or 5 s.

The PF reported that after the flare, the rest of the landing was normal, he put the levers in the beta range, the PM called out "2 beta", and the aeroplane stopped very quickly He moved the levers back to idle and did not use the thrust reversers.

The PF specified that he could not have compensated for an asymmetry without realising it; indeed, with one engine idle and the other engine providing the approach power or more, the asymmetry is such that the corresponding compensation using the rudder pedals cannot go unnoticed.

The crew explained that they only carried out the tests on RH engine #2 after the occurrence. The aeroplane had, on several occasions, experienced power problems on RH engine #2: on take-off, on taxiing from the apron, and when taking off again after several training flights.

The crew reported that prior to the flight preceding the occurrence flight, they were verbally informed that the RH #2 FCU[5] had been changed. They had not found any record of this change in the Aircraft Technical Log (ATL). They were frustrated by this inconsistency but were not worried, as all the events had occurred on the ground.

2.3.2 Engine power management

The engine's output torque is used as the main parameter for adjusting power. The Operations Manual - Part B contains the power adjustment information that shall be used to determine the correct torque settings for take-off and cruise based on the altitude and ambient temperature. It is specified that if one of the two engines cannot reach the torque corresponding to the calculated take-off power, the flight must be cancelled.

Crews shall report differences of 1 psi (torque measurement unit).

Other engine parameters, such as the inter-turbine temperature (ITT) and the gas generator speed (Ng), are monitored to ensure that they are within acceptable limits.

The crew can monitor engine parameters using the following interface:

Garmin interface (source: Garmin)

Engine parameters

On the approach, the PF manages the power, the PM selects the propeller speed

Figure 1: management of engine parameters by the crew (source: BEA)

[5] The fuel control unit meters the fuel according to the position of the power lever. The gas generator speed (Ng) is controlled by regulating the fuel flow to the combustion section of the engine. The effective output of the engine is directly dependent upon the compressor turbine speed.

2.3.3 Conclusion on operational aspects

No particular operational element was identified as a contributing factor to the event.

Increasing the speed on approach, just like the transition to idle on final, is related to the operation of the Twin Otter on approaches with variable weather conditions. These are common practices at the operator's with crews adapting to approaches in conditions that are sometimes difficult, without aids such as a windshear detection system and in the absence of reliable meteorological data.

The drop in speed cannot be explained either by a propeller pitch positioning anomaly or by a power anomaly on a single engine, since the crew did not observe any asymmetry.

The crew's lack of monitoring of the engine parameters can be explained as follows:

- they were carrying out a visual approach;
- the PM focused his attention on speeds, potentially due to the narrow speed range authorised (between the adopted speed and the Vmax);
- and lastly, flying habits (checking variations in engine speed by ear).

2.4 Aircraft information

2.4.1 Airframe

Manufacturer	DE HAVILLAND		
Type	DHC-6 – 300		
Serial number	412		
Registration	F-OCQZ		
Entry into service	20 February 1974		
Certificate of Airworthiness	247858	31 March 2008	
Airworthiness review certificate	24785886921	from 13 July 2020	to 13 July 2021
Operation as on 4 May 2021	44,573 flight hours/ 55,810 cycles		

2.4.2 Engine(s)

		LH engine #1	RH engine #2
Manufacturers		PWC	PWC
Type		PT6 A-27	PT6 A-27
Serial number		PCE-PG0400	PCE42464
Date of manufacture		2 September 2009	25 March 1986
Date of installation		21 April 2020	21 April 2020
Total operating time (cycles) on	date of installation	*TSO: 2,992 - CSO: 3,054*	*TSO: 2,311- CSO: 3,847*
	since last inspection	*3 hours (2 cycles)*	*3 hours (2 cycles)*
	on 4 May 2021	*6,833 h/7,157 cycles*	*12,733 h/35,667 cycles*

From November 2019 to July 2020, a Major Inspection was carried out on the aeroplane. During this inspection, the hot parts of both engines were inspected. The aeroplane was equipped with the Genesys Garmin 950 under a Supplemental Type Certificate (STC).

2.4.3 History of engine problems - Period from 1 January 2021 to 3 May 2021

The in-flight engine power problem reported by the crew was preceded by several similar faults or malfunctions.

The history was established based on the ATL data. This log records any anomalies observed by pilots or maintenance technicians, as well as the work carried out to resolve them and the approvals for return to service (APRS).

On 1 January 2021, on releasing the brakes, the crew observed an effective output of 48 psi instead of the expected 50 psi on LH engine #1. LH FCU #1 (which had logged 119 operating hours since the previous overhaul) was replaced by a FCU from a Pratt & Whitney workshop.

Thirty-one flights were carried out.

On 17 January, the maintenance team made adjustments to this FCU.

Four flights were carried out.

On 19 January 2021, the crew observed an effective output of 46.4 psi at take-off, instead of 48.4 on RH engine #2. RH FCU #2 (which had logged 3,161 operating hours since the previous overhaul) was changed. A FCU from a FCU manufacturer-approved repair organisation (Keystone Turbine) was installed.

Thirty-six flights were carried out.

On 12 February, the crew rejected the take-off, as the effective output on RH engine #2 was 45 psi. No anomaly was detected on the ground during the setting operations.

Twenty-four flights were carried out.

On 24 February, RH engine #2 stayed in idle. The ground checks carried out on the air section of the fuel system did not find any anomaly, and the malfunction could not be reproduced.

There were no flights between 24 and 28 February.

On 28 February, during consecutive training flights, RH engine #2 power did not increase during the third take-off. The propeller overspeed governor system was replaced and the aeroplane was returned to flight.

The aeroplane did not fly until 19 March (an auto feather problem was corrected on 17 March), after which around 30 flights were made.

On 9 April 2021, RH engine #2 stayed in idle when the power lever was moved to maximum power.

Tests carried out on RH engine #2 did not reveal any anomaly. The fuel system of RH engine #2 was checked and cleaned, no anomaly was detected. The maintenance actions carried out in the meantime concerned the autopilot (fault detected on 30 April during the daily check, replacement of the elevator trim servo).

The aeroplane did not fly until the training flights conducted the day before the event.

With regard to the DHC-6 registered F-OFUT, which is operated and maintained under the same conditions, the ATL was also consulted, and no problems were identified regarding engine power.

2.5 Post-event examinations

2.5.1 Actions carried out by the operator after the event

2.5.1.1 Autopilot malfunction

After the return leg to Wallis, tests were carried out on the autopilot. No malfunction was identified. As a precautionary measure, Aircalin replaced the following parts:

- trim actuator;
- pitch attitude computer;
- altitude transmitter.

2.5.1.2 Power problems

As indicated in the history of the flight, following the event, the crew carried out a ground performance test on RH engine #2: the engine torque stayed at 5 psi.

The maintenance team carried out tests on both engines and obtained the following results:

- the parameters of LH engine #1 were within the tolerance limits;
- RH engine #2 stayed in idle.

At the request of the engine manufacturer (PRATT & WHITNEY), the FCUs and the fuel-oil heat exchangers of both engines were replaced and sent to its workshops for further examination.

2.5.2 Examination of FCUs by PRATT & WHITNEY as part of the safety investigation

The FCUs were examined in several steps: an initial naked-eye and borescope inspection, bench testing, disassembly and new visual inspection, analysis of the elements found. The FCU was tested in accordance with the Honeywell manual (CMM 73-20-31).

During the physical inspection of the two FCUs, debris was found at the P3 and Py ports.

The borescope inspection carried out on the P3 and PY air inlets of LH FCU #1 revealed the presence of flaky debris, black granular deposits, fibres, yellowish particles and signs of corrosion.

The borescope inspection carried out on the P3 and PY air inlets of RH FCU #2 revealed the presence of black granular deposits, yellowish crystals and fibres.

Bench testing of the two FCUs did not reveal any operating anomalies that could explain the event.

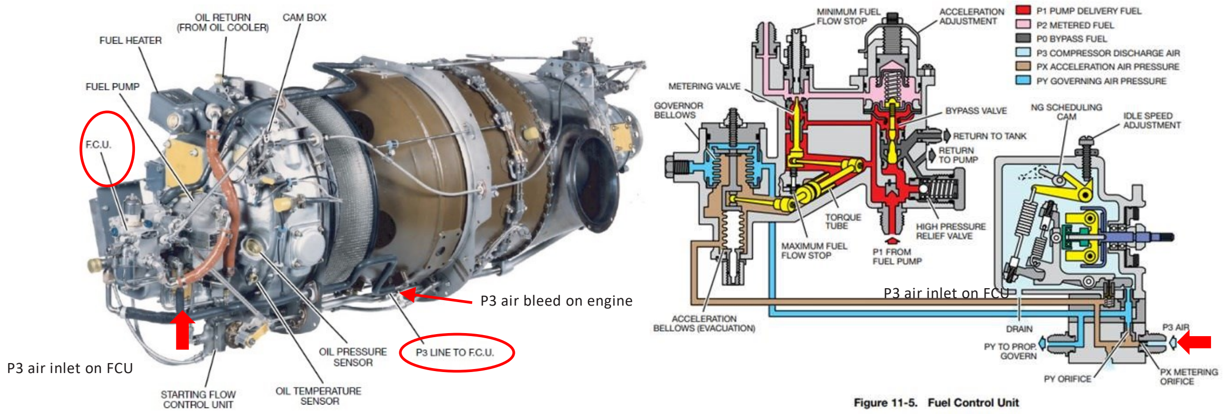

Figure 2: FCU and P3 supply line on PT6A27 (source: PRATT & WHITNEY)

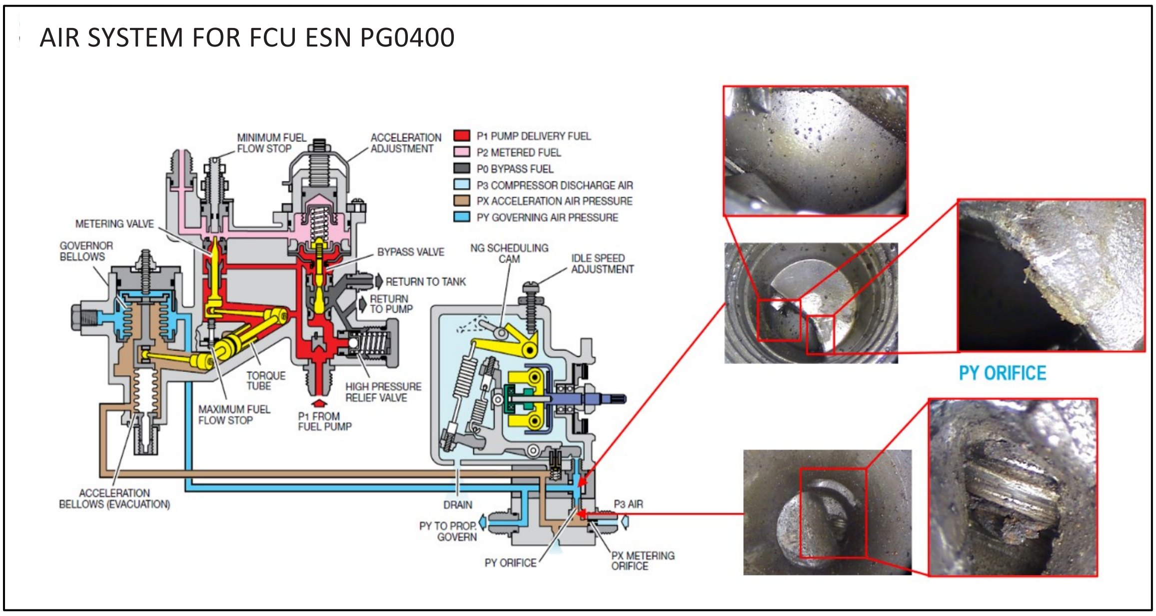

Figure 3: examination of FCU # 1 (source: PRATT & WHITNEY)

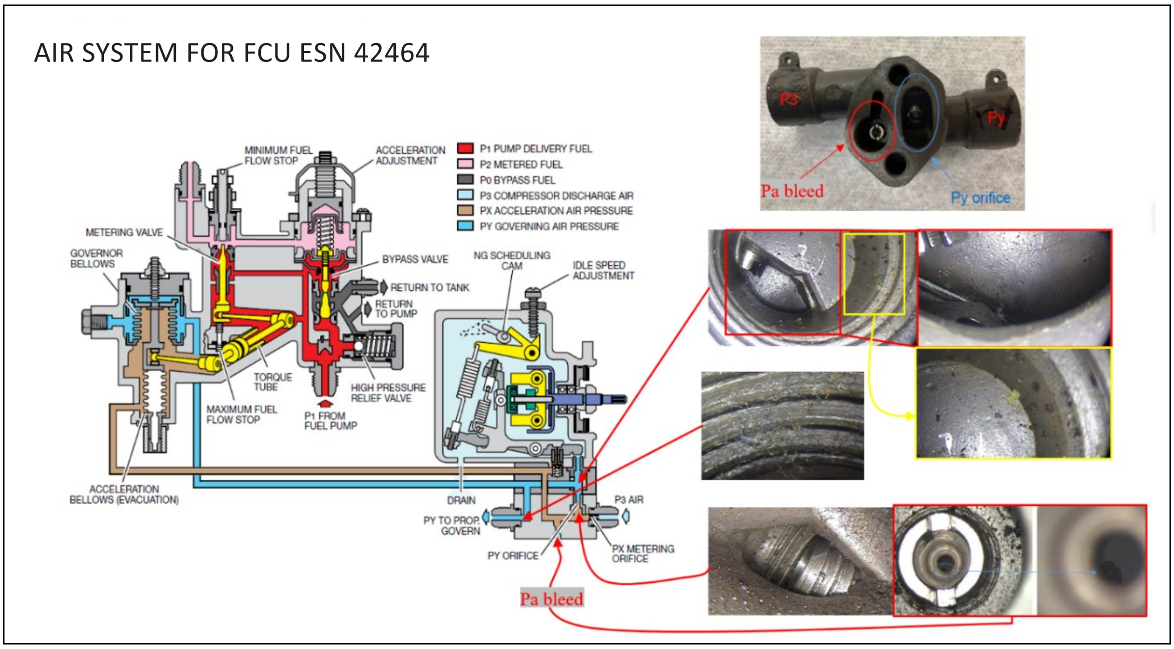

Figure 4: examination of RH FCU #2 (source: PRATT & WHITNEY)

Black debris was found in the Px and Py air passages, as well as black, flaky debris in the Px bleed cavity, comparable to the debris found in the Py orifice inlet during the borescope inspection. The Py port was contaminated with black debris.

The chemical analysis showed that the residues observed were an aggregation of grease (probably engine oil), different types of environmental elements and corrosion by-products. The environmental elements detected were chlorine, sodium, carbon, sulphur, calcium, silicon, magnesium, fluorine and cotton fibres.

According to PRATT & WHITNEY, the debris in the Py orifice inlet of LH FCU #1 could have affected the operation of the FCU and led to engine acceleration malfunctions (slow or no engine acceleration).

According to PRATT & WHITNEY, the debris found during the examination of RH FCU #2, in the location where it was found, would not have had a direct impact on the operation of the FCU. However, PRATT & WHITNEY highlighted the fact that this debris could have migrated into the air section and could have momentarily altered the operation of the FCU.

2.5.3 Examination of fuel-oil heat exchangers

The examinations carried out on the fuel-oil heat exchangers did not reveal any major malfunctions that could explain the event.

2.5.4 Additional examinations during overhaul of RH engine #2 and replacement of LH FCU #1

At the end of September 2021, new malfunctions associated with torque fluctuations were observed in flight. These malfunctions were not reproduced on the ground and what caused them could not be determined. The operator brought forward the overhaul of RH engine #2 (PCE 42464) and replaced the FCU of LH engine #1.

The examinations carried out by TAE (an Australian MRO service provider) as part of the overhaul of RH engine #2 did not reveal any leaktightness faults in the bearings or in the scavenge pump.[6]

The engine air section as a whole showed no particular contamination. Light black pitting was observed as well as minor water contamination (on the fuel side).

In addition to these examinations, LH FCU #1 was examined and no contamination was observed.

2.5.5 Conclusions on post-event examinations

Contamination was observed on both FCUs installed at the time of the event. This contamination was made up of corrosion by-products, environmental elements and grease (probably engine oil). Corrosion may have led to material detaching which aggregated in part due to the presence of greasy material.

According to PRATT & WHITNEY, the level of contamination on both FCUs was much higher than that usually found on FCUs.

[6] A leaktightness fault was one of the hypotheses put forward by PRATT & WHITNEY to explain the presence of greasy substances in the air section of the FCUs.

PRATT & WHITNEY specified that this contamination could have affected the operation of the FCUs, causing slow or uncontrolled acceleration, instability and malfunctions at the various power levels.

2.6 Cause of contamination of FCUs

This chapter is an analysis of the faults that could have led to the contamination of both FCUs installed at the time of the event (fault tree).

2.6.1 Hypothesis of past contamination

Both FCUs were installed shortly before the events (120 h for the FCU on LH engine #1 and 87 h for the FCU on RH engine #2). They had been replaced following malfunctions related to lower-than-expected power levels. The source of the FCUs was questioned, as the procurement of spare parts was particularly difficult during the lockdown period.

No evidence was found to support the hypothesis of initial contamination, i.e. contamination linked to previous use and not detected in the workshop, or linked to transport and storage conditions.

2.6.2 Hypothesis of contamination from engine

The presence of grease (probably engine oil) in both FCUs led to suspicions of an oil leak on both engines. As the air inlet is at the compressor, oil contamination could spread via the P3 port. However, the examination of RH engine #2 did not reveal any leaks likely to have contaminated the FCU air section.

2.6.3 Hypothesis of contamination linked to operations

External pollution (salt-laden air, different types of external pollution, humid environment) can be taken in by the engine's air flow and spread via the bleed air that supplies the FCU.

Recent models are equipped with a P3 filter. According to PRATT & WHITNEY, this type of filtering system has the following benefits:

- filtering of airborne particles larger than 10 µm;
- capture of any oil vapours;
- opportunity to detect contamination during filter inspection.

According to PRATT & WHITNEY, P3 filters help to reduce the risk of FCU air contamination, but they do not eliminate all possible sources of contamination (particles smaller than 10 µm).

On the date of the occurrence, neither the engines installed on F-OCQZ nor those installed on F-OFUT were equipped with a filtering system.

No power problems were reported on F-OFUT. The absence of a filter cannot therefore be considered as the sole explanation for the contamination.

2.6.4 Hypothesis of contamination related to compressor desalination washing

Contamination may arise from maintenance operations related to air ports supplying the FCUs, in particular compressor washing (washing compressor and turbine of PT6 engines).

2.6.4.1 Procedure used for compressor and turbine desalination washing

The PRATT & WHITNEY Maintenance Manual specifies the following:

- engine maintenance must remove salt, dirt and other baked-on deposits that accumulate over time and cause engine performance deterioration as well as corrosion or sulphidation[7];
- if operating in a salty environment, the compressor, compressor turbine and external engine should be washed after the last flight of the day. The three washing operations are carried out using drinking water;
- PRATT & WHITNEY recommends to do a compressor turbine desalination wash after the compressor desalination wash for salt-laden or harsh environment, since the compressor desalination wash will transfer salt deposits into the turbine. When desalination washes are done in conjunction with each other it is a must that compressor wash be done first.

Aircalin's maintenance technicians installed all the equipment (for washing the compressor and its turbine) and then proceeded with the actual washing operation, i.e. directing water to the engine, which was rotated by the starter, and then drying it.

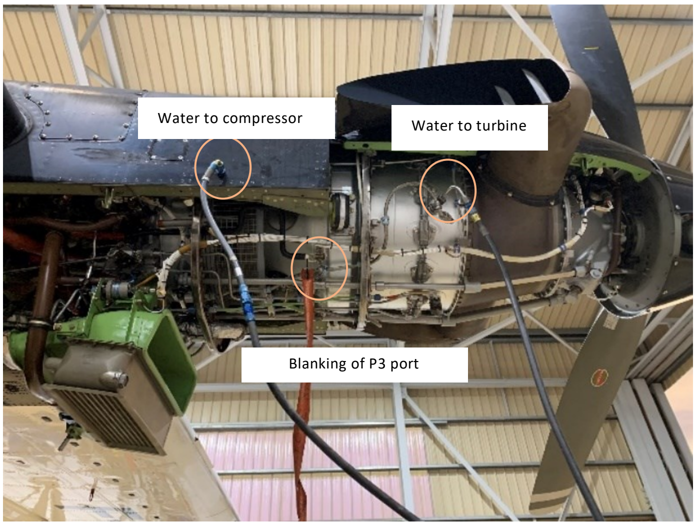

Figure 5: installation of compressor washing equipment (compressor and turbine sections) (Source: Aircalin)

According to PRATT & WHITNEY, washing the compressor and turbine at the same time can lead to a build-up of water between the compressor and turbine, which might not be evacuated when drying the engine during the engine power-up. This water can be evacuated gradually. It can also find its way into the air section and, in contact with some metals, this water can lead to corrosion.

- Procedure 71.00.00 "Engine washing" requires the line upstream of P3 to be removed to prevent water from entering the FCU air section. If the P3 port is not removed or if it is not sufficiently protected when washing the compressor, contaminants can migrate from the compressor to the FCU via this P3 line.

[7] PWC Maintenance Manual PART No 3013242, chapter 71.00.00 "Engine washing".

Aircalin's maintenance technicians did not remove the line completely: for the engines, in the configuration of those installed on F-OCQZ at the time of the event, Aircalin's maintenance technicians used a cap on the P3 air outlet. This cap is a locally manufactured tool.

PRATT & WHITNEY indicated that this method is adequate if the outlet is effectively blocked and the line is dry when the cap is removed. PRATT & WHITNEY did not, however, express an opinion on the effectiveness of this method.

At the time of the event, both engines on F-OFUT were equipped with a safety valve, which was the subject of an STC. With this safety valve ensuring quick sealing of the P3 port, the line upstream of the port did not need to be removed.

2.6.4.2 Regularity of compressor washing

In November 2020, OSAC carried out an audit of the Part-145 organisation at Wallis airport. A lack of traceability in the inspection of repetitive tasks (turbine washing) was observed.

During the BEA investigation, doubts were also expressed during interviews, regarding the regularity of compressor washing. These doubts were strengthened by the lack of traceability.

According to PRATT & WHITNEY, not regularly washing the compressor does not directly affect contamination of the FCUs.

2.6.4.3 Compressor recovery wash

In the event of a reduction in engine performance, a compressor performance recovery wash must be carried out using a dedicated wash fluid containing chemical additives to remove more stubborn deposits. (This was done on 18 February and 16 April 2021).

2.6.5 Conclusions on cause of contamination of FCUs

The analysis of the possible faults causing the contamination led to the following results:

- the recurrence of loss of power events and the fact that the FCUs did not come from the same workshops meant that a fault related to FCU procurement was not considered as the most likely hypothesis;
- the engines of both aeroplanes were not equipped with a filtering system to limit contamination in the air section of the FCUs via the P3 port;
- the presence of a greasy substance in the FCUs could not be explained;
- the regularity of the compressor desalination washes (every evening) could not be established with certainty. However, according to PRATT & WHITNEY, this does not directly affect contamination of the FCUs;
- if the P3 port is not removed or if it is not sufficiently protected when the compressor is washed, elements may migrate from the compressor to the FCU. At the time of the event, this potential weakness existed on the F-OCQZ engines, but not on the F-OFUT engines, due to the installation of a safety valve (modification under an STC);
- compressor washing should be followed by turbine washing to remove the deposits transferred to the turbine. Washing the compressor and turbine at the same time does not eliminate all of the water. The impact of this water on the contamination of the FCUs was not established.

This has been the only dual PT6A engine failure event associated with contamination of the FCUs over the last 10 years, i.e. an event rate of 0.024 events/million hours.

The Canadian civil aviation authority, Transports Canada indicated that, on average over the last five years, the rate for loss of power events associated with contamination of the air section of the FCU has been around 0.2 events/million hours. Unless common modes are present, the probability of a dual event is extremely low.

The evidence gathered during the investigation was unable to identify with certainty, a failure mode common to both engines and to precisely establish the cause of the contamination of the FCUs. The only possible common explanation identified during the investigation might be the lack of sealing of the P3 port when the compressor is washed.

2.7 Information on processes for handling recurrent faults

The recurrence of the faults and the fact that the aeroplane was returned to flight after four similar occurrences without the cause being identified raised questions about the processes for handling recurrent faults and in particular, the skills that maintenance teams can call upon, the support they receive, the possible pressure they undergo to return the aircraft to flight and, lastly, the impact of cooperation between pilots and maintenance teams.

2.7.1 Processing power losses

Aircalin’s maintenance technicians performed the troubleshooting procedures in compliance with the steps described in the Viking Maintenance Manual for the Twin Otter and in the PRATT & WHITNEY Maintenance Manual specific to the PT6 engine.

The Aircalin’s technicians indicated that when an engine remains in idle, the causes may be:

- the control cables;
- the FCU;
- the start control valve;
- the injectors.

After the replacement of the FCUs, four loss-of-power events were reported on RH engine #2. Concerning the first event, no anomalies were found during the setting operations on the ground. For the second event, the air section was inspected and no malfunction was found. Following the third event, the propeller governor was replaced. Following the fourth event, the aeroplane remained on the ground for more than three weeks due to another malfunction. Ground tests carried out did not reveal any anomaly, the engine was cleaned and the aeroplane was returned to flight.

The ATL did not mention any specific processing of the recurrent faults or malfunctions.

2.7.2 Sharing of experience and support

2.7.2.1 Wallis site

At the Wallis site, eight people are employed in the production department for line and base maintenance of the two DHC-6s (a production manager, two APRS technicians, four mechanic assistants without APRS privileges and one storekeeper).

For DHC-6s, the following work can be carried out at the Wallis site:

- all maintenance inspections up to and including the major inspection;
- for PT6A-27 engines:
  - standard replacement,
  - build-up/tear-down,
  - borescope inspection.

The technicians in charge of the maintenance of the DHC-6s all have a Part-66 licence, and are type-rated on this aeroplane. The maintenance of technical competency is based on this activity. Only one of the technicians had received dedicated training in engine setting, which limits skill-sharing.

The AOG (aircraft on ground) decision rests entirely with the technicians who hold the relevant qualification (qualification associated with APRS) at Wallis. The “fleet status” document for the Twin Otter is sent to the maintenance control centre each time there is a change in the aeroplane’s status.

2.7.2.2 Technical Office (within the Technical Division)

The Technical Division, based at Noumea, manages the Technical Office, as well as the logistics and production (maintenance).

The Technical Division assumes regulatory responsibility for the maintenance of aeroplanes maintained in the PART-145 workshop.

The maintenance control centre (MCC) manages and supports the Aircalin maintenance teams at the main base and subcontractors at line stations for aeroplane repairs in compliance with company procedures. It carries out weekly checks of repeated complaints.

The ATL pages are scanned and sent to the Technical Office as they are received. The Technical Office is responsible for identifying repeated complaints and developing and planning a rectification programme to determine the effectiveness of the programme implemented.

The faults observed on F-OCQZ were thus reported to the Technical Office as they occurred. However, during the COVID period, the workforce was reduced with this possibly affecting the continuing airworthiness of the Twin Otters.

The head of the Technical Office emphasised the difficulty of processing a fault that is not straightforward, such as the power problems reported in the ATL. When the FCU was replaced a second time, a warning was issued about a decline in equipment reliability. The Technical Office focused on the suppliers of the FCUs, the shop reports of the previous FCUs were requested and the procurement policy was changed: the procurement of FCUs having undergone a basic repair was stopped, and only components having undergone an overhaul would now be accepted.

2.7.2.3 PRATT & WHITNEY (engine manufacturer)

The Technical Office reported that there were no exchanges with PRATT & WHITNEY during the period of the recurring faults.

2.7.3 Absence of flight or maintenance recorders

In the oversight audit of Aircalin conducted by the New Caledonia civil aviation authority (DAC-NC) in November 2020, the need for cross-functional cooperation within the company was identified to process precursory events, stressing that this was all the more important as the DHC-6s are not equipped with flight data recorders.

The following points were mentioned during the interviews conducted as part of the BEA's safety investigation:

- crews having doubts about certain repairs carried out by maintenance teams at the Wallis base;
- maintenance technicians having doubts about the pertinence of pilot reports regarding several faults which they considered to be minor;
- a lack of discussions, with exchanges limited to the content of the ATL, sometimes with very little explanation, such as the wording "Nil defect found";
- in contrast, a lack of pilot reports regarding certain faults guided by the desire to maintain good relations.

This lack of cooperation between mechanics and pilots may have had an impact on the processing of recurring faults. This was particularly true in the case of the power losses, which were not systematically reproduced on the ground, and even more so in the absence of a data recorder or the recording of data trends by the Garmin computer.

2.7.4 Conclusions on handling recurrent faults

Based on the statements collected during the investigation, it appeared that feedback from the Wallis base to the Technical Division was effective. However, the manufacturer was not contacted. The repeated faults did not lead to any specific immediate action, apart from a warning about future procurements. Lastly, the fact that only one technician was trained in engine setting did not facilitate the comparing of experience.

It was not systematically possible to reproduce the recurring faults on the ground, and F-OCQZ was not equipped with recorders. In this context, exchanges between pilots and maintenance technicians, using the ATL or other communication tools, were the only source of information. However, cooperation between pilots and technicians was sometimes inadequate.

2.8 Continuing airworthiness actions

In previous years, PRATT & WHITNEY had issued several Service Bulletins (SB) concerning the installation of filters on the line between the compressor and the FCU to prevent contamination of the FCU's air section, in particular:

- recommended SB 1205 in 1974;
- optional SB 1343 in 1981;
- optional SB 1448 in 1990, supplemented by SB 1495 concerning the installation of a drainage system to avoid disassembling the P3 air line between the compressor and the FCU when washing the compressor.

Both engines were built as per specifications that did not incorporate a filter on the P3 line. None of the SBs were classified as mandatory by PRATT & WHITNEY, nor were they the subject of an airworthiness directive published by the certification or oversight authorities.

None of the previous operators of these engines had incorporated a filter in compliance with one of the SBs. As a result, the engines were not equipped with a filtering system, either when they were built or during operation.

Aircalin did not seek advice from PRATT & WHITNEY regarding the implementation of these filtering systems prior to the occurrence.

2.9 Actions taken by the operator since the event

Aircalin's Safety and Compliance Department initiated around 10 investigations into the DHC-6 fleet, in particular following requests from pilots concerned about the decrease in the aeroplanes' reliability. A meeting was held in April 2022 to share conclusions about the DHC-6s. The topics covered included:

- washing of aeroplanes;
- daily inspections;
- washing of compressors.

The Technical Office recruited a person dedicated to the continuing airworthiness of DHC-6s. Discussions took place with the engine manufacturer's local representative, enabling them to establish contact and improve collaboration in the future.

Advice was provided on:

- compressor washing procedures;
- training of maintenance technicians;
- improving engine performance monitoring.

P3 filters were fitted. An SD card was introduced in the Garmin 950 to monitor certain engine parameters.

3 CONCLUSIONS

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

Scenario

Between 12 February and 4 May 2021 (the day of the event), four malfunctions relating to engine power problems on the ground had been observed and recorded in the Aircraft Technical Log (ATL). For all four events, the problems were not reproduced during the maintenance operations that followed.

The day before the event, the pilots had carried out a night training flight without noticing any power problems.

During the freight commercial air transport flight between Wallis and Futuna on 4 May 2021, the pilots decided to increase the approach speed by 10 kt due to possible turbulence. The speed range between the adopted speed and the Vmax was therefore reduced (by approximately 8 kt). The pilots were used to this speed increase, which was a strategy for adapting to the lack of reliable weather data and the absence of a windshear indicator in the aeroplane.

After momentarily reducing the power to idle to decrease speed, the PF noticed that the power did not come back up, and he did not hear the expected noise from the engines. The speed continued to drop despite his attempts to increase power and finally moving the levers up to the full power stop. He managed to land the aeroplane on the runway with a nose-down input and an early flare. The crew did not notice any thrust dissymmetry when increasing power.

Ground tests carried out by the crew confirmed the power problem on the RH engine (engine #2). The LH engine (engine #1) was not tested immediately, and the problem was not subsequently confirmed.

The examinations carried out on the FCUs of both engines revealed an unusual level of contamination, made up of environmental elements and grease (probably engine oil), which may have caused malfunctions such as a lack of engine power increase, although this was not established with certainty.

The investigation was unable to determine with certainty the cause of this contamination.

Contributing factors

The investigation led to the identification of weak factors that may have contributed to the contamination of the FCUs:

- operation in salt-laden air with engines configured without filters before the P3 port. The presence of a filter limits the contamination without eliminating all the contamination sources;
- washing processes that differed from those recommended by the manufacturer, potentially including weaknesses, in particular with regard to the protection of the P3 line.

The investigation resulted in the identification of weaknesses in the processing of recurring faults:

- the absence of an alert or of specific processing in the event of repeated faults;
- limited exchange and support opportunities offered to the maintenance teams at Wallis, due in particular to the geographical distance and restricted travel during the pandemic period;
- difficulties in confirming some malfunctions in the absence of recorders;
- reduced cooperation with the engine manufacturer.

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