Accident

Aircraft Type and Registration:	Cessna 208B, G-CPSS	
No & Type of Engines:	1 Pratt & Whitney Canada PT6A-42A turboprop engine	
Year of Manufacture:	2004 (Serial no: 208B1059)	
Date & Time (UTC):	23 March 2024 at 1154 hrs	
Location:	Cranfield Airport, Bedfordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Engine corrosion	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	31 years	
Commander's Flying Experience:	1,663 hours (of which 1,278 were on type) Last 90 days - 13 hours Last 28 days - 7 hours	
Information Source:	AAIB Field Investigation	

Synopsis

Following a low oil pressure warning and smoke from the engine exhaust, the pilot diverted to a nearby airport. Following detailed inspection of the engine by the manufacturer, significant corrosion was identified which had formed holes, leading to a loss of oil from the reduction gearbox housing into the engine exhaust. The corrosion resulted from numerous unapproved engine compressor washes which had been carried out without the drain plug being removed. This was a known issue on the engine, and the manufacturer had added warnings to the Approved Maintenance Manual and issued a Service Information Letter. The operator and contracted maintenance provider confirmed that any future engine washes would only be conducted by approved maintenance personnel and in accordance with the Approved Maintenance Manual.

History of the flight

The aircraft was on a ferry flight back to its main base following maintenance. The pilot reported that a scheduled A check completed prior to the flight, which included a check of the engine oil level, had confirmed that the oil contents was indicating in the middle of the green band on the gauge.

When the engine was started, the exhaust gas temperature had peaked at 818°C but it was only above 800°C for 4 seconds. All other engine checks were normal. During take-off full power was achieved on the engine, with temperatures and pressures indicating in their

respective green bands. The pilot levelled out in the cruise with a power setting of 900 ft lbs torque and a propeller speed of 1,750 rpm.

Approximately seven minutes later, while transiting overhead Cranfield Airport at 3,300 ft amsl, the engine low oil pressure warning light came on. The pilot requested to divert into Cranfield, flying an immediate left hand turn to a downwind position and conducting a fast descent. During the descent the pilot noted smoke coming out of the engine exhausts. The aircraft landed on Runway 21, with the pilot reporting the engine performance was normal, but smoke was still coming from the exhausts. This became more significant when the engine power was reduced to idle during the flare to touch down.

The pilot taxiied off the runway, immediately shut down the engine and exited the aircraft. He went to open the engine cowlings to check the oil level and identify any leaks but noticed what appeared to be flames from within the right engine exhaust. The responding Airport Fire and Rescue Service discharged three CO_2 fire extinguishers into the exhaust. The aircraft was then towed to a parking stand.

Engine examination

The engine was removed and sent to the manufacturer's facility in Canada for further investigation. The manufacturer confirmed that there was a large amount of oil and water in the exhaust duct. Even when the drain plug for the duct was removed the liquid didn't drain out and the drain hole was found to be clogged by carbon build up. Once this obstruction was removed the liquid drained away freely. Disassembly and inspection of the engine confirmed a crack in the power turbine vane outer ring and significant corrosion, which had created two holes in the Reduction Gearbox (RGB) rear housing. This was considered by the manufacturer to be the source of the loss of oil.

Failure mechanism investigation

Further enquiries with the engine manufacturer identified that the exhaust duct drain plug was present to allow water to drain away when carrying out engine compressor and turbine washes. More frequent washes had been recommended on the engine by the manufacturer to address turbine blade sulphidation and salt corrosion on compressor blades. However, the manufacturer had seen an increase in corrosion in the same area of the RGB housing, when the drain plug hadn't been removed or the drain hole had become blocked, preventing water from draining away during and after washes. They had issued a Service Information Letter (SIL PT6A-206) in March 2013, which was then revised in 2016, to remind operators and maintainers of the importance of removing the drain plug and ensuring that water was able to drain freely. Otherwise, corrosion in the RGB housing was likely, which could lead to loss of oil and low oil pressure warnings.

The manufacturer had also added a warning in the Engine Maintenance Manual relating to engine washes in January 2024 stating:

> **CAUTION:** IF YOU DO NOT REMOVE THE EXHAUST DUCT DRAIN, IT CAN RESULT IN COLLECTION OF WASH LIQUID AND CAUSE SEVERE RGB REAR HOUSING CORROSION WHICH CAN LEAD TO LOW OIL PRESSURE CONDITION DUE TO OIL LEAK FROM RGB HOUSING (REF. SIL NO. PT6A - 206).

Along with an additional step in the maintenance procedure to ensure the wash liquid was draining freely:

> (16) Make sure that the wash fluid came out of the exhaust duct drain. Remove any obstruction from the drain fitting.

Incident aircraft's maintenance history

Maintenance of the aircraft was sub-contracted by the operator to an approved Part 145 maintenance provider. The maintenance provider's facility was located at a different airfield to the one where the aircraft was based and operated from. The operator confirmed that approximately five years ago they had been experiencing problems with blade corrosion, with previous engines needing overhaul hundreds of hours short of the expected on-wing life. They stated that they were advised by their Continuing Airworthiness Management Organisation (CAMO) and by the engine repair facility that had carried out previous work on the engines to increase the number of compressor washes being carried out on the engine.

Following this advice, they internally introduced a routine to conduct engine compressor washes on the aircraft once a week. This process did not reference the Approved Maintenance Manual (AMM) and did not require removal of the drain plug. The maintenance activity was not documented in the aircraft logbook and the pilots who carried out the work did not issue a Certificate of Release to Service afterwards, nor would they have been able to do so given the non-compliances in the process.

The operator stated that they were instructed how to carry out a compressor wash by both their CAMO and their previous maintenance organisation by watching a demonstration. This instruction suggested no tools were required. They were not aware of the requirement to remove the drain plug or that this level of wash was classed as maintenance rather than a user task and as such they were unaware of the requirement to complete a Release to Service.

The contracted Part 145 maintenance provider stated they had not issued any authorisations for pilot maintenance to be conducted remotely by the operator. They suggested that as many of the PT6A variations do not have the removable drain plug, which is only fitted to the larger engines, this may have been where the confusion arose.

They stated that "a compressor desalination wash on the small/medium engines is a simple case of connecting a water source to a factory installed fitting, motoring the engine & then carrying out the drying run. As such, this would not be classed as a 'complex task'."

Pilot maintenance regulations

UK CAA regulations in Part 145.A.30 (j) state:

> *'By derogation to points (g) and (h), in relation to the obligation to comply with Annex III (Part-66), the organisation may use certifying staff and support staff that are qualified in accordance with the following provisions:*
>
> *…*
>
> *4. If an aircraft is operated away from a supported location, the organisation may issue a limited certification authorisation to the pilot on the basis of the flight crew licence held, subject to being satisfied that the pilot has carried out sufficient practical training ensuring that the pilot can accomplish the specified tasks.*
>
> *…'*

The AMC for 145.A.30(j)(4) states:

> *'1. For the issue of a limited certification authorisation,*
>
> *(a) the pilot should hold either an airline transport pilots licence (ATPL) or a commercial pilots licence (CPL) in accordance with Regulation (EU) No 1178/2011 and, as applicable, Regulation (EU) 2020/723.*
>
> *2. In addition, the limited certification authorisation is subject to the MOE containing procedures to address the personnel requirements of point 145.A.30(e). The procedures should be accepted by the CAA and should include as a minimum:*
>
> *(a) completion of adequate continuing airworthiness regulation training as related to maintenance;*
>
> *(b) completion of adequate task training for the specific task(s) on the aircraft. The task training should be of sufficient duration to ensure that the individual has a thorough understanding of the task(s) to be completed, and that it will involve training in the use of the associated maintenance data;*
>
> *(c) completion of the procedural training as specified in Part-145.*
>
> *2.(i) Typical tasks that may be certified and/or carried out by a pilot who holds an ATPL or a CPL are the minor maintenance or simple checks included in the following list:*
>
> *(a) Replacement of internal lights, filaments and flash tubes;*
>
> *(b) Closing of cowlings and refitment of quick-access inspection panels;*

(c) Role changes, e.g. stretcher installation, dual controls, FLIR, doors, photographic equipment, etc;

(d) Inspection for, and removal of, de-icing/anti-icing fluid residues, including the removal/closure of panels, cowls or covers that are easily accessible but that do not require the use of special tools;

(e) Any check/replacement that involves simple techniques that are consistent with this AMC and that have been agreed by the CAA

3. The validity of the authorisation should be limited to twelve months, and may be renewed if there has been satisfactory recurrent training on the task(s) for which the pilot holds an authorisation.'

The CAA advised that they considered all engine compressor washing to be a complex task which is outside the scope of Part 145.A.30 (j)(4) and should only be certified by appropriately licenced maintenance personnel. There are also provisions in Part-M, specifically M.A.803, for pilot owner approved maintenance. The CAA advised that engine compressor washes would not fall within the limited scope of these regulations either.

Certificate of Release to Service

Following any maintenance activity, a Certificate of Release to Service must be issued by appropriately authorised certifying staff.

Part 145.A.50 states:

'(a) A certificate of release to service shall be issued by appropriately authorised certifying staff on behalf of the organisation when it has been verified that all maintenance ordered has been properly carried out by the organisation in accordance with the procedures specified in point 145.A.70, taking into account the availability and use of the maintenance data specified in point 145.A.45 and that there are no non-compliances which are known to endanger flight safety.

(b) A certificate of release to service shall be issued before flight at the completion of any maintenance.'

CAA Review

A review of the general issue of operators conducting compressor washes on the PT6 engine was carried out by the investigation. This identified a broader problem than just the UK, with the national airworthiness authority in Australia issuing an Airworthiness Bulletin to clarify their requirements. This concern was raised with the CAA and they were requested to review whether further guidance was necessary to address the problem in the UK. They advised that their records confirmed there were 169 aircraft registered in the UK fitted with the PT6 engines, with 11 Part 145 approved maintenance organisations approved to maintain those engines. They stated:

"From the fleet, we have actively sampled three maintenance providers, which together have responsibility for 25 aircraft, regarding their compressor wash practices and the authorisation of the personnel undertaking this work.

Additionally, we have had numerous discussions and meetings with CAA airworthiness colleagues who have direct oversight of these CAA approved organisations to establish compliance checks against Part 145 regulations.

We have also reviewed safety data and non-compliances to Part 145 and all this leads us to conclude there is no additional evidence of unapproved operator maintenance taking place with regard to the issue identified with G-CPSS.

With regard to published guidance, the UK Continuing Airworthiness regulations are clear on the specific requirement for authorisations. By virtue of the fact these are approved organisations, they are aware of these regulations and our position is supported by the review that we have carried out as previously mentioned."

Analysis

As the operator was not conducting the engine compressor washes in accordance with the AMM for the aircraft, they were not aware of the requirement to remove the drain plug nor to ensure that the wash fluid drained freely out of the engine exhaust casing. They were also not aware of the engine manufacturer's warning that this would result in corrosion of the RGB, leading to oil loss and a low pressure warning. Eventually the wash fluid accumulating in the exhaust duct caused sufficient corrosion in the RGB that during the accident flight, holes formed in the casing and oil was lost into the hot exhaust duct. This triggered the low oil pressure warning and generated the smoke seen coming from the exhaust.

The implications of the oil loss are that if the engine continues to operate without sufficient lubrication, it will overheat and seize. As the Cessna 208B is a single engine aircraft, this could potentially result in a forced landing off airfield. In this case it was fortunate that the aircraft was overhead a suitable airfield at the time the warning light illuminated, allowing an immediate diversion and landing while the engine was still operating normally.

As the compressor washes were not being conducted in accordance the applicable airworthiness regulations, there were also implications for the legality of the continued use of the aircraft. The aircraft was routinely being used for parachute operations at the time.

As part of the investigation the CAA was requested to consider whether the investigation findings raised broader concerns that needed to be addressed for the UK fleet of PT6 engines. They advised that their assessment was that this was not a widespread concern, and issuing further guidance was unnecessary.

Safety actions

Following this accident and once the operator became aware of the RGB corrosion issue, they stopped conducting compressor washes on all their aircraft and have confirmed that this maintenance will now only be carried out by their approved maintenance provider.

The current maintenance provider has confirmed they are aware of the corrosion issue, will conduct compressor washes in accordance with the AMM instructions and have put in place a 200 hour repeat inspection of the drain plug hole to prevent blockages.

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