

FACTUAL NOTES, ENGINE TEARDOWN INVESTIGATION IN SUPPORT OF ACCIDENT INVESTIGATION OF AIRCRAFT REGISTRATION NO. N4531K PERFORMED FOR NATIONAL TRANSPORTATION SAFETY BOARD (NTSB).

NTSB Accident No. Not available at this time P&WC Ref. File No: 17-148

1. INVESTIGATION PARTICIPANTS

The powerplant investigation was performed on October 03 and 04, 2017 at Dawson Aircraft Inc., Clinton, Arkansas. The following individuals participated in the investigation as representatives of their respective organisations:

Addison D. Baxter	FAA Safety Inspector General Aviation
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Leslie Ederer	Pratt & Whitney Canada Accident Investigator
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2. ENGINE HISTORY

PWC PT6A-15AG S/N 14144
Data plate Airforce Turbine indicating PT6A-34AG

Hours Since New: Last log book entry 3-20-17 shows 13209.8

Cycles Since New: Unknown

Hours Since Overhaul: Unknown

Cycles Since Overhaul: Unknown

3. ENGINE EXAMINATION

All positional references are in relation to view from aft looking forward. Upstream and downstream references are in relation to gas path flow from the compressor inlet to exhaust.

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	ECCN or USML (ITAR) #	-
	P-ECCN or P-USML (Non US Origin)	9E991

- 3.1 **External Condition:** The propeller assembly was still attached to the propeller shaft (Photo No. 1). One of the three propellers exhibited mechanical damages (arrow, Photo No. 2). The undamaged propellers were near the feathered position. The propeller shaft was still attached to the reduction gearbox which was separated from the exhaust case at the “B” flange (Photo No. 3). The exhaust duct was crushed on the bottom portion from impact (Photo No. 4). The gas generator case showed no external impact damage (Photo No. 5), however torsional damage was observed in the inner portion of the gas generator (arrow, Photo No. 6). The PWC engine data plate showed the serial number was PCE- 14144 and that the engine is a PT6A-15AG (Photo No. 7). Attached over the bottom of the PWC data plate is another data plate from Airforce Turbine Service (STC SE7677SW) showing the engine is a PT6A-34AG (Photo No. 7).



Photo No. 1
Propeller assembly and left exhaust stack



Photo No. 2
Bent Propeller and right exhaust stack



Photo No. 3
Reduction gearbox separated at the "B" flange



Photo No. 4
Exhaust duct impact damage



Photo No. 5



Photo No. 6

Gas generator case torsional deformation

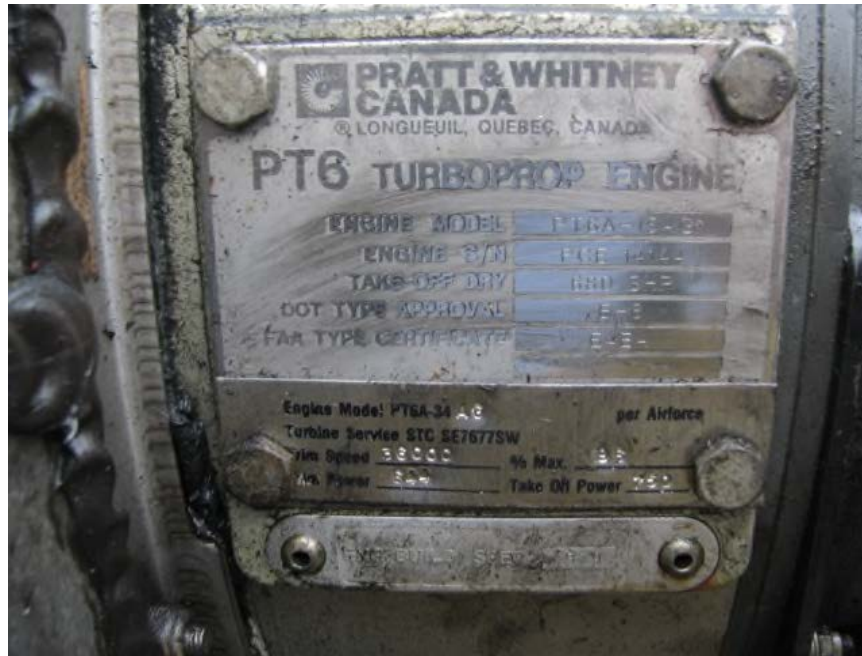


Photo No. 7

3.1.1 External Cases

Reduction Gearbox: The reduction gearbox front housing could be partially rotated. The scavenge and pressure lines were deformed from impact damages. No evidence of oil starvation or distress was observed on the first and second stage planet gear assemblies, which were exposed during engine removal from the airframe (Photo Nos. 8 and 9 respectively).



Photo No. 8

First stage planet gear carrier assembly



Photo No. 9
Second stage planet gear carrier assembly

Exhaust Duct: The two exhaust stacks showed mechanical damages (Photo Nos. 1 and 2). The exhaust duct showed mechanical damages (Photo No. 4).

Gas Generator Case: The gas generator case showed no external damages (Photo No. 5), however torsional damage was observed in the inner portion of the gas generator (Photo No. 6).

Accessory Gearbox: The accessory gearbox showed no damages and could be rotated by hand, continuity was observed with the compressor turbine (Photo No. 10).



Photo No. 10
Accessories gearbox

3.1.2 **Power Control and Reversing Linkage:** The beta lever guide pin was in place (red arrow, Photo No. 11). The propeller reversing lever was displaced at the carbon block outside of the slip ring (white arrow, Photo No. 11). The propeller reversing linkage was in place (red arrow, Photo No. 12). The propeller speed control lever was fractured from the propeller governor (black arrow, Photo No. 12). The reset interconnect rod was complete and secure (white arrow, Photo No. 12). The input lever, reversing cable, and airframe power lever cable linkage was attached and secure on the CAM box (red circle), (white, red and black arrows respectively, Photo No. 13). The start valve to the fuel condition lever was connected (yellow arrow, Photo No. 13).



Photo No. 11

Beta guide pin and the propeller reversing lever



Photo No. 12

Reversing linkage and fractured propeller governor speed control lever

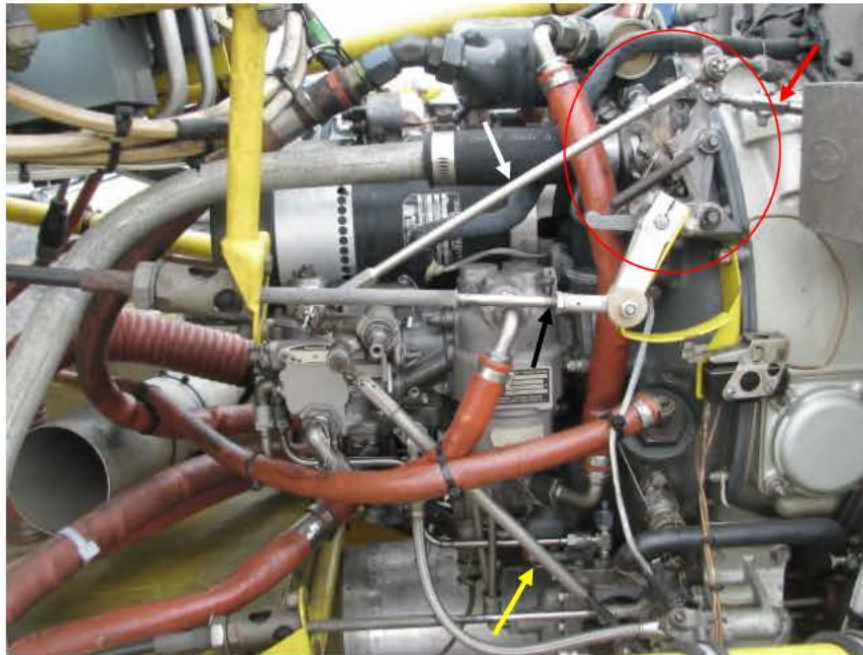


Photo No. 13

CAM box, input lever and airframe power lever cable

3.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The P3 lines connectors were found tight and secure from the fuel control unit to the P3 bowl to the gas generator (circled, Photo No. 14). The P3 filter and bowl were dry (Photo No.15).

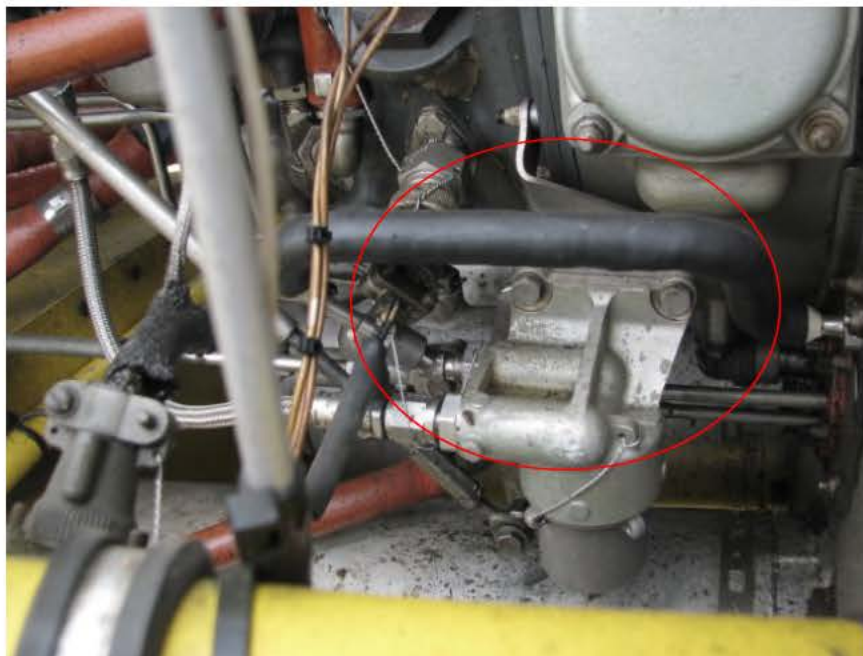


Photo No. 14

P3 at gas generator case



Photo No. 15
P3 filter and bowl

Power Turbine Control (Py): The Py line was found connected and secure from the fuel control unit to the propeller governor (Photo Nos.16 and 17).



Photo No. 16
Py line at the fuel control unit



Photo No. 17
Py line at the propeller governor

3.1.4 Chip Detector and Filters

Reduction Gearbox Chip Detector: The reduction gearbox magnetic chip detector showed no significant metal debris accumulation (Photo No. 18).



Photo No. 18
Reduction gearbox magnetic chip detector

Oil Filter: The oil filter was removed and found to show no metal debris contamination (Photo No. 19).



Photo No. 19
Oil filter

Fuel Filter: The fuel filter was not accessed for the purposes of this investigation

3.2 Disassembly Observations

3.2.1 **Compressor Section:** for the purposes of this investigation were not accessible.

First Stage Compressor Rotor: Examination of the

Front Stub Shaft: The front stub shaft was not accessed for purposes of this investigation.

No. 1 Bearing and Airseals: The No. 1 bearing was not accessed, however the compressor could be rotated freely. The airseals were not accessed for purposes of this investigation.

No. 2 Bearing and Airseals: The No. 2 bearing was not accessed, however the compressor could be rotated freely. The No. 2 bearing airseals were not accessed for purposes of this investigation.

3.2.2 Combustion Section

Combustion Chamber Liner: The outer surface of the liner showed no distress and exhibited normal in-service condition (Photo No. 20). The fuel nozzles were not accessed for the purposes of this investigation.



Photo No. 20
Outer combustion liner

Small Exit Duct: The small exit duct was not accessed for the purpose of this investigation.

3.2.3 Turbine Section

Compressor Turbine Vane Ring: The compressor turbine vane ring downstream showed impact damages to the vanes (Photo No. 21). The compressor turbine vane ring showed no upstream damages to the leading edge of the vanes (Photo No. 22). The inner shroud was cracked in several locations (Photo No. 23). The inner shroud welds and the air slots' shapes were different than those observed on similar application PWC stators (red arrow, Photo No. 23 and black arrow, Photo No. 24 respectively). The trailing edge distances to the end face of the inner shroud also visually appeared to vary from vane to vane (arrows, Photo No. 25). Limited markings on the stator showed 0344R13 and 13-657 (Photo No. 26). Records showed that the CT stator was installed after overhaul repair by Southwest Turbines at engine TSN11959.2. Their repair is not a PWC approved repair.



Photo No. 21
Compressor turbine stator downstream view



Photo No. 22
Compressor turbine stator upstream view



Photo No. 23
Compressor turbine inner shroud side welds



Photo No. 24
Compressor turbine stator air slots



Photo No. 25
Trailing edge vane locations



Photo No. 26
CT stator markings

Compressor Turbine Shroud: The compressor turbine shroud segments showed impact damages from the release of the compressor turbine blades fragments (arrow, Photo No. 27).



Photo No. 27
Compressor turbine shroud segments

Compressor Turbine: The compressor turbine blades were all observed to have fractured (Photo Nos. 28 and 29). Visual examination of all the compressor blade fractures showed no obvious primary blade fracture. All the blades had an appearance of a rough fracture morphology indicative of tensile overload type fractures (Photo No. 30). The compressor disc retaining bolt was properly secured, however during removal it was noted that the bolt was easily untorqued. The upstream view of the compressor disc is shown in Photo No.31. Circumferential rubbing contact with the compressor turbine stator inner shroud was observed for an arc of approximately 120° on the upstream face of the compressor turbine blades (arrow, Photo No. 31). The compressor turbine disc at engine TSN in the records indicated P/N 3013411 S/N 29A424 with part CSN 14,807. The installed disc was P/N 3013411 S/N 20A424 (Photo No. 32). One compressor turbine blade was removed revealing a non PWC manufactured compressor turbine blade, P/N 1L9D9 FAA-PMA (Photo Nos. 33 and 34).



Photo No. 28
Compressor turbine in-situ



Photo No. 29
Closer view of compressor turbine blades damages



Photo No. 30
View of typical fracture surfaces observed on the compressor turbine blades



Photo No. 31
Leading edge view of compressor turbine disc



Photo No. 32
Compressor turbine S/N



Photo No. 33
One compressor turbine blade removed from the disc



Photo No. 34
The removed compressor turbine blade showing P/N

ITT Probes, Busbar, and Harness: The inter turbine temperature probes were all fractured (Photo No. 35). The harness and busbar were intact (Photo No. 36).



Photo No. 35

Power turbine housing, inter turbine temperature probes and upstream view of first stage power turbine stator



Photo No. 36

Inter turbine temperature busbar and harness

Power Turbine Stator Housing: The power turbine stator housing was intact (Photo No. 35).

Power Turbine Vane Ring: The upstream view of the power turbine vane ring showed impact damages to the leading edge of several vanes and the vane ring baffle was displaced (Photo No. 37). The downstream view of the power turbine vane ring showed impact damages to all the vanes and a static crush mark in the vane baffle from contact with the displaced power turbine disc hub (Photo No. 38).



Photo No. 37
Upstream view of the power turbine stator



Photo No. 38
Downstream view of the power turbine stator

Power Turbine Shroud: The power turbine shroud contact surface was almost completely obliterated by mechanical damages (arrow, Photo No. 39).



Photo No. 39
Power Turbine Shroud

Power Turbine: The power turbine assembly which was displaced due to impact damages to the exhaust case showed several of the blades to be fractured (Photo No. 40). The power turbine could be rotated with some difficulty. The retaining bolt retaining bolt was found secure with noticeable undo torque required, however at some point during the untorque process the bolt seized and could not be removed. Examination of the fracture surfaces of the PT blades insitu showed a fracture morphology indicative of tensile overload (Photo No. 41).



Photo No. 40
Power turbine

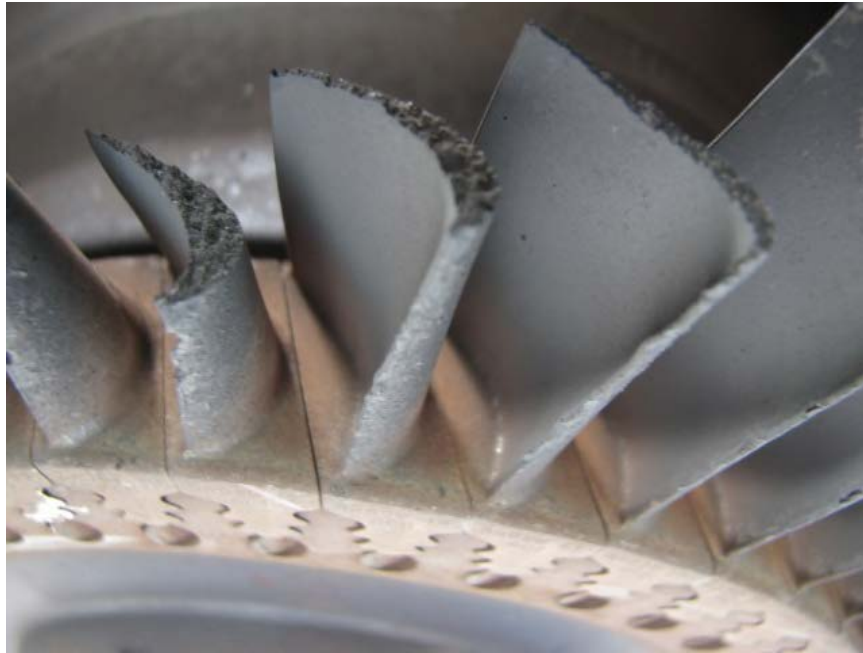


Photo No. 41

Power Turbine Shaft and Shaft Housing: The power turbine housing was deformed due to deformation of the exhaust duct during impact (arrow, Photo No. 42, note the “pock marks from debris impact on the inside of the exhaust case (inset)). A loss in continuity was observed between the power turbine and first stage reduction gearbox assembly. The power turbine shaft and shaft housing was not accessed for the purposes of this investigation.



Photo No. 42

3.2.4 Reduction Gearbox

The reduction gearbox had separated at mating flange “B”. Although the reduction gearbox was not accessed further for this investigation, the first stage reduction gearbox carrier planet gear assembly, ring gear and second stage sun-gear and coupling showed no distress (Photo No. 7). The first stage carrier planet assembly could be freely rotated by hand. The second stage carrier planet gear assembly and ring gear showed no distress (Photo No. 8). Due to external impact damages the second stage carrier planet gear assembly could only be partially rotated by hand.

3.2.5 Accessory Gearbox: The accessories gearbox showed no damages (Photo No. 10). The accessories gearbox was not accessed further for the purposes of this investigation.

Photo No. 44



Photo No. 45
One of the ignitor leads at the gas generator case



Photo No. 46
The other ignitor lead at the gas generator case

Ignition Plugs: Both plugs were in place, secure and intact. The ignitors removed showed no distress (Photo No. 47).



Photo No. 47
Intact ignitor plugs

3.3.2 Fuel System

Fuel Heater: The fuel heater was intact and in place (Photo No. 48).



Photo No. 48
Fuel heater

Fuel Pump: The fuel pump was not accessed for purpose of this investigation (red arrow, Photo No. 49).

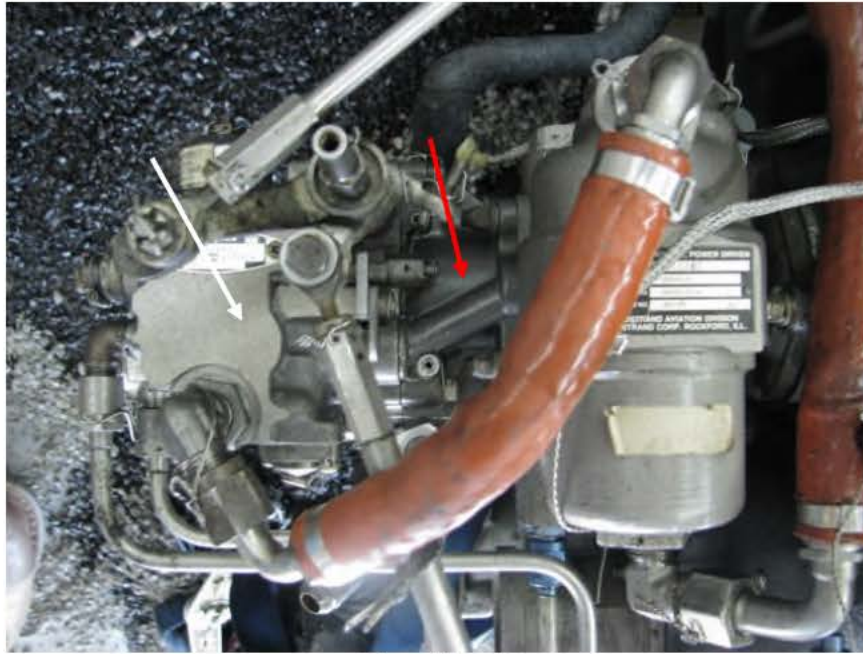


Photo No. 49
Fuel pump

Fuel Control Unit: The fuel control unit was not accessed for purpose of this investigation. The unit was in place and secure (white arrow, Photo No. 49).

3.3.3 Air System

Compressor Bleed Valve: The compressor bleed valve was in place and secure. The bleed valve was removed and could be easily moved by hand (Photo No. 50).



Photo No. 50
Bleed off valve

3.3.4 Oil System

Propeller Governor: The propeller governor was damaged during impact (Photo No. 51)



Photo No. 51
Propeller governor

Overspeed Governor: The overspeed governor was in place and showed no damages (Photo No. 52).

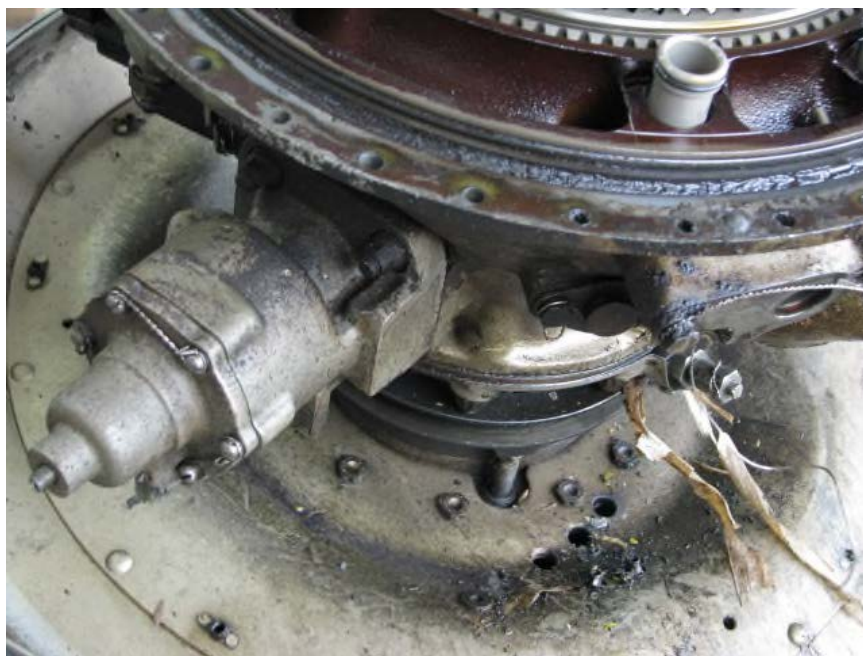


Photo No. 52
Overspeed governor

6. **CLOSING:**

These factual notes are based upon observations made on October 03 to 05, 2017, and may be altered or corrected on the basis of further information.

PRATT & WHITNEY CANADA CORP.



Leslie Ederer
Service Investigation
October 05, 2017