

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR24LA070

ENGINE EXAM SUMMARY

September 11, 2024

A. ACCIDENT

Location: Stratford, CA
Date: January 10, 2024
Time: 10:10 local
17:10 UTC
Airplane: AIR TRACTOR INC AT-502A

B. ENGINE EXAM SUMMARY

PARTICIPANTS

IIC	Scott Johnson National Transportation Safety Board Federal Way, WA
Aerospace Engineer AS-40	Robert Hunsberger National Transportation Safety Board Washington, DC
Air Safety Investigator	Michel Pitsikoulis, ENG Pratt & Whitney Canada Corp. Longueuil, Quebec
Air Safety Investigator	Frederic Cardinal, ENG Pratt & Whitney Canada Corp. Longueuil, Quebec
Staff Mechanical ENG R&D Systems	Matt Zolnierczyk Woodward INC. Love Park, IL

C. SUMMARY

On January 10, 2024, about 1010 Pacific standard time, an Air Tractor AT-502, N6126U, was substantially damaged when it was involved in an accident near Stratford, California. The pilot was not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 137 agricultural flight.

The pilot reported that during takeoff the airplane failed to develop full power. At about 200 ft above ground level (agl), the engine rolled back to near idle. The pilot's attempt to vary power lever inputs did not affect engine power output. The pilot maneuvered the airplane between two houses onto a grove of small trees. During the landing roll, the airplane impacted several trees, resulting in substantial damage to the wings and fuselage.



Figure 1. Front view of accident airplane at the crash site.

Postaccident examination of the airframe was completed by the Federal Aviation Administration inspector at the accident scene and revealed no preaccident mechanical malfunctions or failures that would have precluded normal operation. Power control continuity to the power lever was established from the cockpit control to the engine. The inspector reported that both the wing fuel tanks had been breached. The fuel soaked the surrounding ground under the airplane. The inspector had the high-pressure pump filter and last chance filter removed by the operator. A visual examination revealed that both contained fuel and were clean. A fuel sample was obtained from the fuel farm and no contaminants were observed. The inspector reported that the engine was perfectly clean with no oil drips, everything looked tight, and nothing was out of the ordinary. The engine was removed from the airplane under FAA oversight and shipped in an engine manufacturer shipping container to the engine manufacturer in Canada for additional examination and testing.

D. DETAILS OF THE INVESTIGATION

1.0 Engine information

Model Series:	PT6A-65R
Serial Number:	PCE97015
Rated power:	1376 shaft horsepower
Engine Total Time:	26641.3
Time since inspection:	26 hours
Propeller Manufacturer:	Hartzell
Propeller Model:	HC-B5MP-3C

Examination of the recovered wreckage revealed that the airplane was equipped with a Pratt & Whitney Canada (PWC) PT6A-65R engine. The engine produces a takeoff power of 1,376 shaft horsepower. The PT6A engine is a 2-spool turbo-prop engine. The power section module consists of two stage power turbines (PT), which drive the propeller through a 2-stage planetary reduction gearbox (RGB). The gas generator (GG) module consists of a compressor section, which has 4 axial, and 1 centrifugal stages driven by a single-stage compressor turbine. The combustion chamber is a reverse-flow annular type. The constant-speed, variable pitch propeller is a single-acting type and is hydraulically controlled. The engine power management system consists of a hydro-mechanical fuel control unit (FCU), which governs the GG speed by delivering fuel flow to the engine in response to the power lever angle, compressor discharge pressure and GG speed. The propeller governor and

overspeed governor provide governing of the PT and propeller speed as well as protection against propeller and PT overspeed.

The 5-bladed Hartzell propeller on the engine was part number (P/N) HC-B5MP-3C, serial number (S/N) EVA2206.



Figure 2. Side view of accident engine on engine box.

2.0 Engine uncrating

After shipment to Canada removing engine from crate, it was noted that the exhaust case had torsional buckling on the top and bottom surfaces. The power turbine was visually examined, and deformation was identified that precluded running the engine on the test cell in the as received condition. A spare power section module, provided by the manufacturer, was installed for testing.



Figure 3. View of the bottom of engine with exhaust casing torsional buckling

3.0 Pressure Sensing Lines

A P3 (compressor discharge air) leak check was performed at 80 psi, by introducing air pressure through a test stand at the P3 air filter bowl and capping the GG pick-up flange. Leak-Tec leak detector was applied to the P3 system B-nuts and rigid tubing. No bubbling was detected between the gas generator P3 pick-up to the FCU air inlet port.

4.0 Engine observations and notations

A portion of the propeller governor housing including the beta valve was separated and missing. The power control linkages had continuity and were free to move across the full range of travel except for reverse. The reverse cable was bent at the front of the engine which prevented movement of the FCU and CAM box linkages into the reverse position. The FCU condition lever was free to move from the shutdown valve to the flight idle stop. The propeller shaft did not turn by hand.

The accessory gearbox (AGB) and reduction gearbox (RGB) magnetic chip detectors (MCD) were free of debris and appeared typical of similar service run engines. The P&WC mechanics noted that the AGB MCD was installed in the oil tank drain port instead of the AGB MCD port erroneously during shipping preparation. The lockwire at both positions were cut. The MCD and drain plug had been removed during on scene inspection. The oil filter was oil wetted and had a small amount of nonmetallic sediment observed between the filter pleats and in the filter housing. The fuel filter was fuel wetted and free of debris. The P3 filter was also free of debris.

The incident engine power section was separated at the C flange. After the power section was separated, the GG compressor turbine (CT) rotor spun freely. The PT remained seized and could not be rotated by hand. The 1st and 2nd stages of the PT (PT1 and PT2) were separated for inspection and during disassembly the stages were found to be misaligned consistent with impact damage, which resulted in contact with the case. The PT1 rotor disk exhibited rubbing of the shrouded blade sealing knife edges. The No.3 and No. 4 bearings were intact, oil wetted, and rotated smoothly. The RGB was separated at the A flange and removed from the power turbine shaft. Rotation of the first and second stages of the planetary gear assembly was possible with no abnormal sound or feel. The compressor turbine was visually inspected and found in normal operational condition. A borescope was used to inspect the upstream side of the 1st-stage compressor turbine rotor and nozzle vanes. The Ng rotor was turned via the AGB accessory mounting pad and no damage was observed.

The FCU and fuel pump were removed and taken to their respective test benches and tested to the manufacturers component maintenance manual (CMM). The results of the tests found both FCU and fuel pump operated within the respective manufactures' standards.

Fuel Control Unit

Woodward MFR	66503
ASSEY. NO	8061-3320
S/N	11496447

Fuel Pump

Model NO. 399700
P/L NO. 399701-5SB-732
P&W C NO. 3033808
Serial NO. 3523

The Propellor governor was disassembled, and the magnetic coil connector was observed soiled and appeared burnt. Electrical testing will be accomplished to ascertain the condition of the connector. No other anomalies were noted with the propellor governor.

Propellor Governor

Woodward Governor Company
P/N 8230-034 SB-031
S/N 2253468
REV N ASSY DATE 01/20

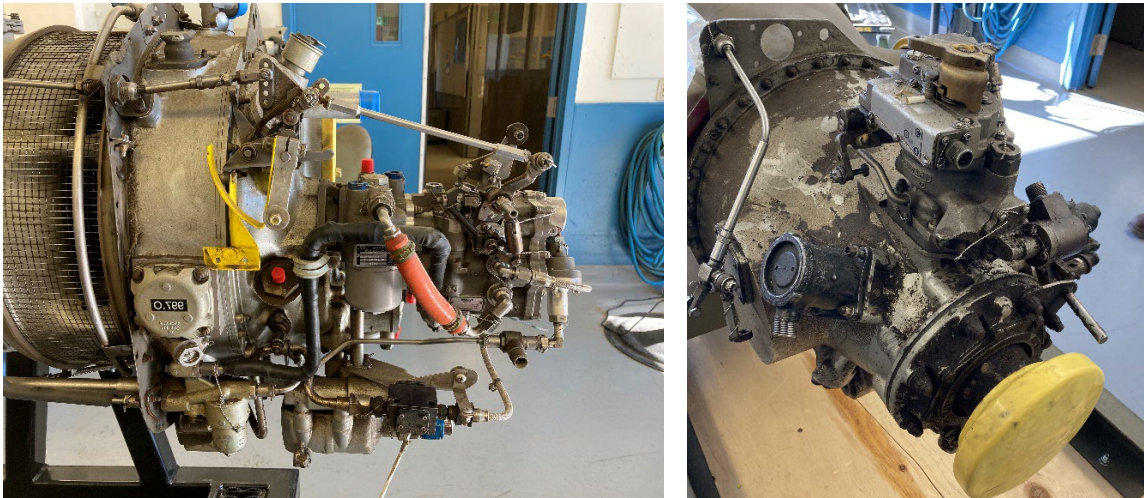


Figure 4. View of Fuel Control Unit, Fuel pump and prop governor.

5.0 PT6A-65R, ESN PCE-97015, Test Cell Run

Due to the damage to the engine power section, a substitute PT6-65B power section was utilized, serial number: PS 32133, and the accessory controls were reinstalled and rigged in accordance with the engine maintenance manual (EMM). The substitute power section included a spare propeller governor/constant speed unit. The engine was then staged in the PWC Plant 1 test cell area in Longueuil, Québec, Canada.



Figure 5- ESN PCE-97015, as Received at the PWC Test Cell Area



Figure 6- ESN PCE-97015, as Received at the PWC Test Cell Area

The engine was installed in the test cell and started normally. Following a short dwell period at ground idle speed to raise the oil temperature, the engine slowly accelerated to approximately 35,000 RPM (95% Ng). The test cell plenum pressure change confirmed that the compressor bleed valve (BOV), closed normally during

engine acceleration. Later data review showed the BOV was slow to close. The test cell T5 temperature (inter turbine temperature) readings began to fluctuate, and the engine was shut down for troubleshooting. Continuity checks of the test cell wiring and the engine T5 harness isolated the issue to the T5 harness that was installed with the spare power section. No additional testing could be completed due to the inaccurate T5 signal and risk of overtemperature.

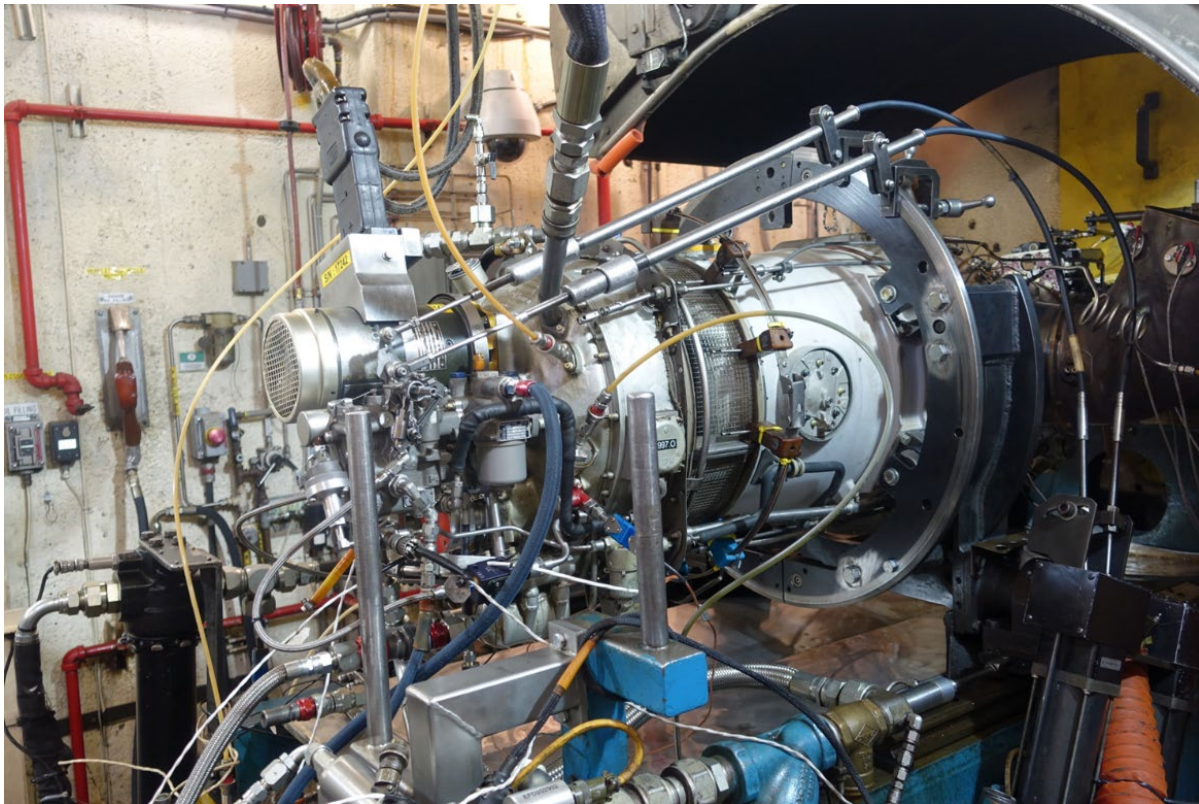


Figure 7- ESN PCE-97015, Installed in Test Cell

6.0 Compressor bleed-off valve summary

Review of the first engine run test data and hesitation heard during the engine speed sweep, resulted in a follow-up bench testing of the BOV. Air leakage around the piston of the BOV and P3 gasket were observed. A bench test pressure check of the BOV revealed an abnormal amount of air leakage around the piston. Disassembly of the BOV revealed the piston ring set was stuck within the piston groove. A comparison of the BOV actuation characteristics between test cell data from a production engine and the abbreviated accident engine test cell run found that the accident engine BOV was slower to close as the engine accelerated. A subsequent examination by PWC laboratory, revealed abrasive and adhesive wear on the piston rings and piston groove. The abrasive and adhesive wear was consistent with environmental debris and/or by the twist observed on the BOV metal piston ring.

During the disassembly of the BOV two assembly part numbers (PN) 3112714 & 3123532, were observed on the BOV cover. The overall diameter of the BOV piston confirmed that the valve was configured per PN 3112714. The BOV assembly serial number was confirmed to be SN 672.

DallasAirmotive
40591 Airport Road
New London, NC 28127
CERTIFICATE NO. YRR2491L

PT6A-65R	Gas Generator S/N: PCE97015	T.S.N.: 23597.2	C.S.N.: 47167	T.S.O.: 9329.3	C.S.O.: 18314
PT6A-65R	Power Section S/N: P597050	T.S.N.: 23590.5	C.S.N.: 46009	T.S.O.: 3930.9	C.S.O.: 8740

DISASSEMBLED, CLEANED, INSPECTED, REPAIRED AND REPLACED PARTS AS REQUIRED. COMPLIED WITH HOT SECTION INSPECTION. CLEANED AND PRESSURE/FLOW CHECKED FUEL NOZZLES. COMPLIED WITH THE LATEST REVISIONS OF PRATT & WHITNEY CANADA SERVICE BULLETINS 13096, 13143, 13258, 13338, 13365, 13399, 13422, 13457, INSTALLED NEW OIL FILTER. INSTALLED NEW P3 FILTER. ENGINE RE-ASSEMBLED WITH ALL NEW SEALS AND GASKETS, TESTED AND PRESERVED. ALL WITH REFERENCE TO BULLETIN INSTRUCTIONS, PRATT & WHITNEY CANADA OVERHAUL MANUAL 3032843R42 LIGHT OVERHAUL DATED 14 JAN 2011, MAINTENANCE MANUAL 3032842R48 DATED 8 OCT 2010 AND OTHER DATA AND METHODS ACCEPTABLE TO THE ADMINISTRATOR.

CT VANE RING FLOW CLASS 6.23 8S1
PT STATOR FLOW CLASS 20.12 2S1
CT DISK DIAMETER 9.205"
CT BLADE TIP CLEARANCE .016

CORRECTED ENGINE PERFORMANCE									
SHP	Ng %	Ta °F	Tt °C	SFC	POWER CHECK Tt TARGET	DATA PLATE SPEED	Tt PULL DOWN REQUIRED	Tt TRIMMER	
								P/N	ADJUSTED
1173	96.13	1338	725.6	.552	N/A °C	36050/96.13 %	43.3 °C	3053995CL10	24.2

LIFE LIMITED COMPONENTS INSTALLATION (NOTE: REFER TO S/B13002, LATEST REVISION, FOR APPROVED LIFE LIMITS)

Name	Part Number	Serial Number	Total Cycles	Cycles Rem	Name	Part Number	Serial Number	Total Cycles	Cycles Rem
Rotor Sig 1	3038901	71A845	12,066	11,934	Impeller	3036897	3E255	17,217	6,783
Disk Sig 2	3033512	13A823	17,217	6,783	Disk CT	3040311	75A416	9,310	5,690
Disk Sig 3	3033513	33A091	17,217	6,783	Disk Sig 1 PT	3029312	26A111	18,814	11,186
Disk Sig 4	3033514	47A277	17,217	6,783	Disk Sig 2 PT	3029313	4N658	18,814	11,186
Spacer Sig 4	3114590-01	47A985	17,217	6,783					

This engine has been repaired and inspected in accordance with current regulations of the Federal Aviation Administration and is approved for return to service. Repair done on file at this repair station under work order: RPR27275

Signature: _____ Date: 24 APRIL 2012

DallasAirmotive
40591 AIRPORT ROAD, NEW LONDON, NC 28127
CERTIFICATE NO. YRR2491L

WORK ORDER NUMBER	ENGINE SERIAL NUMBER	MODEL	DATE
RPR27275	PCE97015	PT6A-65R	4/24/2012
ENGINE T.S.N.	ENGINE C.S.N.	ENGINE T.S.O.	ENGINE C.S.O.
23597.2	47167	9329.3	18314

ACCESSORY INSTALLATION				
NAME	P/N	S/N	T.S.O.	REMARKS
FUEL CONTROL	8061-328B	2165217	0	
FUEL HEATER	10585K	897	0	
FUEL PUMP	309701-5	3529	0	
HP BLEED VALVE	3112714-01	3N672	0	
OIL FILTER	3059258-01		NEW	1000 HOUR LIFE
T1 TRIMMER	3053995CL10	NR01062	NEW	1000 HOUR LIFE
P3 AIRFILTER	5029768		NEW	

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CERTIFICATE NO. YRR2491L

WORK ORDER NUMBER	POWER SECTION S/N	MODEL	DATE
RPR27275	P597050	PT6A-65R	4/24/2012
POWER SECT TSN	POWER SECT CSN	POWER SECT TSO	POWER SECT CSO
23590.5	46009	3930.9	8740

ACCESSORY INSTALLATION				
NAME	P/N	S/N	T.S.O.	REMARKS
T5 HARNESS	3112214-01	NR23470	NEW	
CONSTANT SPEED GOV.	8210-034M	2753468	0	
OVERSPEED GOV.	210960B	11517932	0	

Figure 8 – Last logbook entry of BOV inspection

A review of the maintenance records revealed that the BOV had been disassembled, cleaned, inspected and repaired in April of 2012 by Dallas Airmotive.

Submitted by:

Scott Johnson
Air Safety Investigator